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THE PHILIPPINE JOURNAL OF SCIENCE

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STUDIES ON PARASITES OF PHILIPPINE EDIBLE FISHES: I. FAMILY CLINOSTOMIDÆ IN OPHICEPHALUS STRIATUS BLOCH; CLINOSTOMUM PHILIPPINENSIS SP. NOV. WITH NOTES ON THE DEFINITIVE HOSTS*

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FOUR PLATES

Five species of the Clinostomidæ (Lühe, 1901) Odhner, 1902 have been reported from the Philippines: *Clinostomum dalagi* and *Clinostomum pseudoheterostomum* Tubangui,(18) *Euclinostomum multicæcum* Tubangui and Masiluñgan,(19) *Clinostomum abdoni* Tubangui and Garcia, (20) and *Clinostomum ophicephali* Tubangui and Masiluñgan.(21) With the exception of *Clinostomum abdoni,* a mature form found under the the tongue of a domestic cat, and *Clinostomum pseudoheterostomum,* an immature form encysted between the femoral muscles of the frog (*Rana magna* Stejneger), all other species described were based on immature forms encysted either in the eye sockets, pericardium, muscles, or in the gall bladder of *Ophicephalus striatus* Bloch, commonly called *dalag* or *bulig* in Tagalog.

In a recent survey of the parasitic helminth fauna of Philippine edible fishes, of the 300 *Ophicephalus striatus,* measuring 19.3 to 38.1 cm in length, 0.66 per cent were positive for *Euclinostomum multicæcum.* The fish hosts were collected

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[*] This investigation was partly made possible through a grant-in-aid from the Natural Science Research Center, University of the Philippines.

from Laguna de Bay, at Lumbang, Laguna. This is a new locality record for this parasite, since Tubangui and Masiluñgan reported it from Baao, Camarines Sur. All parasites were found close to the muscles just below the visceral lining of the abdominal cavity and they are immediately set free upon cutting the visceral peritoneum. Specimens of *Clinostomum ophicephali* (Plate 1, fig. 1) were found encysted in the gills of 2.2 per cent of the 90 *Clarias batrachus* (Linnæus) commonly called *hito* in Tagalog, measuring 15.24 to 29.21 cm in length. However, this worm was not found in the gall bladder of *Ophicephalus striatus* as reported by Tubangui and Masiluñgan.(21) The positive specimens of *Clarias batrachus* were caught from Laguna de Bay and Pasig River. While *Clinostomum dalagi* was not encountered in all the fish examined, many encysted forms of an apparently new species of *Clinostomum* varying from 1.5 to 5.0 mm were found in 41 per cent of the *Ophicephalus striatus* examined as shown in Table 1.

TABLE 1.—*Comparative data on clinostomid infection of two common Philippine fresh-water fish.*

Comparative data	Fish host		
	Ophicephalus striatus (Local name: dalag)		*Clarias batrachus* (Local name: bito)
	Metacercaria		Metacercaria
	Clinostomum philippinensis	*Euclinostomum multicaecum*	*Clinostomum ophicephali*
Total number			
Examined	300.0	300.0	90.0
Parasitized	123.0	2.0	2.0
Parasites	484.0	4.0	3.0
Incidence, per cent	41.0[a]	0.66[b]	2.2[c]
Average parasite burden	3.93[d]	2.0[e]	1.5[f]

[a] Incidence, per cent $= \dfrac{123 \times 100}{300}$

[b] Incidence, per cent $= \dfrac{2 \times 100}{300}$

[c] Incidence, per cent $= \dfrac{2 \times 100}{90}$

[d] Average parasite burden $= \dfrac{484}{123}$

[e] Average parasite burden $= \dfrac{4}{2}$

[f] Average parasite burden $= \dfrac{3}{2}$

Metacercariæ were collected from *Ophicephalus striatus* bought at irregular intervals from the different markets of Manila and Pasay City. According to the market vendors, the fish were caught from the Pasig River and Laguna de Bay at Taguig, Rizal Province; Bacolor and Candaba, Pampanga Province; Sampaloc Lake at San Pablo City, San Pedro, Biñan, Sta. Cruz and Lumbang at Laguna de Bay in Laguna Province, Luzon Island. The fish caught at Pilar, Bataan Province, although not bought from any of the markets in Manila, were included in the examination. Those from Laguna and Rizal provinces were frequently parasitized. Encysted worms were found among the tissues just outside the eyeball (Plate 1, fig. 2), between the branchiostegal muscles and the linings of the pericardial and opercular cavities, and occasionally either among the muscles and other tissues immediately under the pectoral fins. So far, there has not been any report on the definitive host of Philippine clinostomids from *Ophicephalus striatus*. In order to determine the definitive host, feeding experiments were performed. The results are shown in Table 2.

For whole mounts, metacercariæ freed from the cysts in naturally infected fish and the adults recovered from the buccal cavity of experimentally infected birds[1] (Plate 4, fig. 5) were flattened and fixed in Bouin's picro-formol and stained with Semichon's carmine. Histological preparations both of the metacercaria and the adult were stained in Delafield's hematoxylin and counter-stained in eosin. It should be noted that the descriptions of Philippine clinostomids from *Ophicephalus striatus* by Tubangui(18) and Tubangui and Masilungan(21) were based on larval forms.

This is, therefore, the first attempt to describe the adult of a Philippine clinostomid from *Ophicephalus striatus*.

CLINOSTOMUM PHILIPPINENSIS sp. nov.

Metacercariæ and adult elongate, linguiform, narrower anteriorly than posteriorly (Plate 1, figs. 3 and 4; Plate 2, fig. 1). Principal measurements are given in Table 3. Cuticle about 6.6 to 13.2 microns thick with minute spines throughout entire length of body. Under this is a well developed muscular layer made up of (*1*) a very thin layer of external longitudinal muscles, (*2*) immediately under the preceding is a layer of circular muscles, (*3*) an internal compact layer of longitudinal

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[1] Note ulcerous growth in infected areas.

TABLE 2.—*Feeding records for the determination of the definitive host,* using metacercariæ from Ophicephalus striatus Bloch.*

Birds tested	Localities	Natural parasitism	Infection		Adult *Clinostomum* recovered in bucal cavity		Percentage of recovery	Remarks
			Date	Number of metacercaria fed	Date	No.		
1. *Rallus rallus philippinensis* (Linn.)	Tignoan, Tayabas	(—)	11/5/54	3	----------	----	----	Died 11/7/54. Post mortem examination of digestive tract (—) for *Clinostomum*.
2. *Rallus rallus philippinensis* (Linn.)	Bataan	(—)	4/22/55	5	----------	----	----	Died 4/25/55. Post mortem examination, 4 *Clinostomum* recovered from gizzard undeveloped, dead, black, wrinkled, and brittle.
3. *Capella gallinago megala* (Swinhoe)	Tignoan, Tayabas	(—)	11/5/54	2	----------	----	----	Died 11/7/54. Post mortem examination of digestive tract (—) for *Clinostomum*.
4. *Gallinula chloropus lozanoi* Lletget	Tignoan, Tayabas	(—)	11/5/54	3	----------	----	----	Died 11/7/54. Post mortem examination of digestive tract (—) for *Clinostomum*.
5. *Gallinula Chloropus lozanoi* Lletget	Tignoan, Tayabas	(—)	11/5/54	3	----------	----	----	Died 11/11/54. Post mortem examination of digestive tract (—) for *Clinostomum*.
6. *Nycticorax nycticorax nycticorax* (Linn.)	Tignoan, Tayabas	(+)	----------	----	----------	----	----	30 *Clinostomum* in buccal cavity. Killed to collect parasites.
7. *Nycticorax nycticorax nycticorax* (Linn.)	Tignoan, Tayabas	(—)	----------	----	----------	----	----	Control.
8. *Nycticorax nycticorax nycticorax* (Linn.)	Tignoan, Tayabas	(—)	11/5/54-11/11/54 11/18/54-11/22/54	5 8	---------- ----------	---- 7	---- 87.5	Died 11/22/55. Metacercariae fed 2 hours before death in stomach, excysted and alive.
9. *Nycticorax caledonicus manillensis* Vigors	Tignoan, Tayabas	(+)	----------	----	----------	----	----	10/9/54 with 7 *Clinostomum*.
Do	do	(—)	11/11/54-11/18/54	7	----------	----	----	
Do	do	(—)	11/22/54	6	11/25/54	1	16.66	

Do	do	(—)	11/29/54 12/1/54	2 26	------ 12/3/54 12/4/54	--- 6 20	------ 92.86	12/8/54 all disappeared—natural falling off.
Do	do	(—)	12/15/54-1/20/55 1/20/55	8 8	------ ------	--- ---	------ ------	
Do	do	(—)	1/26/55-1/28/55	21	1/28/55-1/29/55	8	38.09	
Do	do	(—)	2/2/55	2	------	---	------	
Do	do	(—)	2/16/55	13	2/19/55	1	7.69	
Do	do	(—)	2/25/55	6	------	---	------	
	do	(—)	3/2/55	5	------	---	------	Died 3/28/55.
10. *Ixobrychus cinnamoneus* Gmelin.	Obando, Bulacan	(—)	6/6/55-6/30/55	57	------	---	------	Number of cysts fed varying from 1 to a maximum of 15.
Do	do	(—)	7/11/55-7/14/55	19	7/14/55	1	5.26	
Do	do	(—)	7/20/55-9/9/55	131	------	---	------	Maximum no. of cysts per feeding = 36.
11. *Ixobrychus cinnamoneus* Gmelin	Mabitac, Laguna	(—)	6/28/55 6/29/55 6/30/55 7/1/55 7/5/55	10 9 7 7 6	------ 6/30/55 ------ 7/4/55 7/5/55	--- 1 --- 4 6	------ ------ 25.64 ------ ------	Died 7/20/55. Post mortem examination of digestive tract (—) for *Clinostomum*.
12. *Ixobrychus cinnamoneus* Gmelin	Mabitac, Laguna	(—)	7/27/55-9/7/55	30	------	---	------	

* All birds used were kept in cages from 3 to 4 days before infection.

TABLE 3.—*Measurements of twenty-five mounted specimens of metacercariæ and ten adults of Clinostomum philippinensis sp. nov.*

Part of the specimens	Minimum		Maximum		Average	
	Metacercaria	Adult	Metacercaria	Adult	Metacercaria	Adult
BODY	*mm*	*mm*	*mm*	*mm*	*mm*	*mm*
Total length	2.5	4.1	12.5	7.9	8.072	5.82
Maximum width	1.0	1.5	3.95	3.0	2.626	2.62
Total length:						
Maximum width	2.5	2.733	3.164	2.633	3.074	2.221
Distance of posterior edge of acetabulum to anterior edge of ovary	1.065	1.38	4.845	3.105	2.678	2.013
Distance of posterior edge of acetabulum to anterior tip of uterus	0.225	0.18	0.75	0.45	0.496	0.36
Preacetabular length:						
Total length of body	0.141	0.156	0.246	0.248	0.175	0.194
ORAL SUCKER						
Antero-posterior length	0.120	0.27	0.570	0.45	0.370	0.367
Maximum diameter	0.225	0.345	0.870	0.510	0.504	0.438
Acetabulum Antero-posterior length	0.69	0.81	1.66	1.23	1.158	0.973
Maximum diameter	0.675	0.84	1.68	1.20	1.152	0.959
TESTIS						
Ta *						
Maximum length	0.3	0.45	1.275	0.93	0.762	0.657
Maximum width	0.375	0.495	1.275	1.35	0.805	1.043
Tp *						
Maximum length	0.24	0.48	1.02	0.795	0.563	0.618
Maximum width	0.405	0.63	1.65	1.53	0.972	1.162
OVARY						
Maximum diameter	0.075	0.15	0.30	0.345	0.18	0.195

* Ta, anterior testis; Tp, posterior testis.

muscles, and (*4*) a loosely packed layer of diagonal muscles (Plate 3, figs. 1 and 2; Plate 4, figs. 2 and 4). The external longitudinal muscle layer measures 0.99 to 3.3 microns, while the circular muscle layer measures 23.1 to 52.8 microns in thickness. Among the muscle fibers are numerous peripheral excretory canals of the reserve excretory system which are larger posteriorly than anteriorly. The internal longitudinal muscle layer is rather compact and not loosely arranged as the preceding and is about 16.5 to 33 microns thick while the diagonal muscle layer is made up of loosely packed fibers forming bundles of about 6.6 to 13.2 microns. In between the muscle bundles are myoblasts, rather deeply stained as compared to the neighboring muscle bundles. The parenchymal muscles are made up of longitudinal muscle fibers of several layers, widely spaced and occupying the entire length of the body except those occupied by the intestinal cæca, the genital organs and the vitellaria; and the dorsoventral muscle fibers which are less numerous with fewer fibers grouped together ramifying towards the outer part of the body.

Cells believed to be glandular in nature, similar to those found in *Clinostomum chrysichthys* Dubois(4) and *C. phalacrocoracis* Dubois(5) were also noted in *Clinostomum philippinensis* sp. nov. as shown in Plate 3, figs. 1 and 2. The classification of gland cells is that of Dubois.(4, 5)

The measurements of the cells are:

Kind of cell	Length and diameter of cell	Diameter of nucleus
Cells	*Microns*	*Microns*
Preacetabular glandular	18.5 to 36.3 by 14.85 to 17.5	2.64 to 4.95
Colorless glandular	16.5 to 29.4 by 13.2 to 19.8	3.3
Eosinphilic glandular	16.5 to 26.4 by 13.2 to 19.8	3.3

The preacetabular glandular cells are larger than the other gland cells and have finely granular cytoplasm usually with a rather eccentrically located nucleus with a distinct nuclear membrane. The eosinophilic glandular cells are more deeply stained in Delafield's hematoxylin than the other cells although the nucleus is not so deeply stained in eosin as those described by Dubois.(4, 5) The colorless glandular cells are coarsely granulated and smaller than the preacetabular ones and almost of the same size as the eosinophilic cells, and are more numerous towards the area just below the internal longitudinal muscles.

Oral sucker subterminal or ventro-terminal partially retracted, about one half the size of the acetabulum, acetabulum highly muscular, at anterior third of body; pharynx and esophagus hardly discernible; intestinal crura extend laterally a little beyond the oral field and then posteriorly almost the entire length of the body, and are wider and more deeply diverticulate externally and internally in the postacetabular region (Plate 1, figs. 3 and 4; Plate 2, fig. 1), uniting at their distal ends to the two horns of the excretory vesicle (Plate 3, fig. 3).

Histological preparations show that the intestinal cæca are lined by deeply stained columnar cells. (Plate 3, figs. 1, 2, 3, and 4)

Excretory vesicle bicornuate, Y-shaped, opening through a pore at postero-dorsal end of body. Lateral branches ramify anteriorly into smaller ones towards the peripheral region of body (Plate 3, figs. 3 and 4).

Genital organs are median occupying the posterior third of body. Testes coarsely lobed, with the slightly concave and smooth surface facing each other. Anterior testis asymmetrical, more or less triangular, with the right side pointed and not as lobed as the left side. This condition is rather more marked in the metacercaria than in adults. Posterior testis with a wide posterior lobe and two lateral lobes. Cirrus pouch, 0.57 to 0.43 mm by 0.2 mm, enclosing a coiled vesicula seminalis filled with spermatozoa and continuing to a narrow convoluted rather muscular ejaculatory duct connected with the muscular cirrus opening into the genital atrium (Plate 4, figs. 1 and 3). Pars prostatica short, surrounded by prostate cells. Ovary more or less rounded, located between the two testes and towards the right. Arising from the ovary is the oviduct directed towards the left and uniting with the Laurer's canal which opens to the dorsal side of the worm; a little beyond this junction is the vitelline reservoir formed by the union of the two vitelline ducts, meeting at about the same level as the öotype complex. Beyond the öotype are coils of the uterine duct winding through the large diffuse Mehli's gland and some of its coils serving as receptaculum uterinum. Then the uterine duct passes to the right anteriorly beyond the anterior testis to the uterine sac. The latter measures 0.098 to 0.122 by 0.056 to 0.083 mm, and is at times greatly enlarged when filled with eggs. At the lower right side of the uterine sac arises a funnel-shaped structure set almost at right angles to the wall of the sac. This funnel-like structure contracts into a narrow direct passage, the weakly muscled metraterm. The latter discharges into the genital atrium (Plate 2, fig. 1; Plate 4, figs. 1 and 3). The main uterine sac is diverticulate (Plate 4, fig. 1). Eggs measure 0.098 to 0.122 mm by 0.056 to 0.083 mm.

Vitellaria follicular, rounded or elliptical and generally grouped together, postacetabular, intracecal and extracecal and reaching the posterior limit of the intestinal cæca (Plate 1, fig. 4; Plate 2, fig. 1).

The available literature describes six larval forms from fish of non-local source; namely, *Clinostomum dictyotum* (Monticelli, 1893) [Syn. *Distomum reticulatum* Looss, 1885, nec Wright, 1897, *Clinostomatopsis reticulata* (Looss) Dollfus, 1932]; *C. marginatum* (Rudolphi, 1809); *C. complanatum* (Rud., 1809); *C. crysichthys* Dubois, 1929; *C. piscidium* Southwell et Prashad, 1918; C. *africanum* Galli Valerio, 1906; and two Philippine larval forms, from *Ophicephalus striatus;* namely, *C. dalagi* Tubangui 1933 and *C. ophicephali* Tubangui and Masilungan, 1944.

C. philippinensis sp. nov. is easily distinguished from *C. dictyotum* by the longer metraterm; the position of the genital atrium and the nature of the intestinal cæca. *C. philippinensis* is distinguished from *C. marginatum* Rud., 1819 as described by Yamaguti(22) by the shape of the testes and the longer uterine sac in the metacercaria; from *C. piscidium* by the bigger size of the oral sucker and the position of the genital organs. The description of *C. africanum* is rather inadequate and thus proper comparison is not deemed possible. From *C. ophicephali* the present species differs in shape of body as well as the more anterior position of the genital organs and the much shorter uterus. According to Tubangui and Masiluñgan *C. ophicephali* is slipper-shaped, rather small, 2.8 by 1.1 mm with genital organs almost at posterior end of the body. The new species is relatively larger (Table 3) and genital organs are median in the posterior third of the body. The shape of the testes and of the uterus is distinctly different in the two species. Although the average length of *C. philippinensis* sp. nov. is almost twice that of *C. dalagi* yet the latter species falls within the range between the maximum and minimum of that of the new species. However, the average width is rather close in the two species. Since there is a great variation in size, it cannot be a very good criterion in the differentiation between the two species. It is also noted that the metacercariæ are relatively longer than the adult forms in *C. philippinensis* sp. nov., which was also found to be true in *C. complanatum* (Rud., 1809) Yamaguti.(22) Although the nature of the cæcal diverticula and the uterus of the new species is similar to that of *C. dalagi*, yet the shape of the testes is distinctly different; the testes are lobed and triangular while those of *C. dalagi* are pyramidal, smooth and not lobed.

Clinostomum abdoni Tubangui and Garcia(20) from the cat is the first and only adult ever described in the Philippines. *C. philippinensis* sp. nov. from the bird is the second to be described. It is easily distinguishable from *C. abdoni* by the body shape, and less distended uterine sac and more anterior position of the genital organs; from *C. complanatum* (Rud., 1809) as described by Braun(2) and Yamaguti,(22) it is slightly bigger, but the shape of the body, position of the genital organs and genital atrium approaches those of the Japanese species. Although the shape of the testes in the illustration is strikingly similar to that of Yamaguti's yet several specimens had their anterior testis definitely triangular. In all cases, however, the extent of the vitellaria and the diverticula of the uterine sac as shown histologically and the nature of the cæcal diverticula differ from those of Yamaguti's or that of Braun and the eggs are smaller. *C. intermedialis* Lamont is similar to the new species in the postacetabular diverticula of the intestinal cæca, the shape of the testes and extent of the vitellaria. *C. intermedialis* is, however, distinguishable from the new species by the presence of a more prominent pharynx (although Price(17) in his redescription of *C. intermedialis* had doubts of its existence), extent of the uterus as in Price's redescription and the sparseness of the vitellaria.

From the results of the feeding experiments, the definitive hosts are *Nycticorax nycticorax nycticorax* (Linn.) and *Nycticorax caledonicus manillensis* Vigors. However, *Ixobrychus cinnamomeus* Gmelin can be infected, but with difficulty.

Type and paratypes: Dept. of Zoology, University of the Philippines, Helm. Coll. Nos. 156, 206, and 302.

A REDESCRIPTION OF EUCLINOSTOMUM MULTICÆCUM TUBANGUI AND MASILUÑGAN, 1935 *

(TREMATODA: CLINOSTOMIDÆ)

Tubangui and Masiluñgan(19) described as *Euclinostomum multicæcum* a trematode encysted in the muscular tissues of *Ophicephalus striatus* Bloch collected from Baao, Camarines Sur, Luzon. It is unfortunate that the senior author is now deceased, otherwise pertinent data with respect to the parasite could have been available. Moreover, the type specimens in the Bureau of Science parasitological collection, according to the junior author, were completely lost during the battle of Manila in World War II.

The description and illustration of *Euclinostomum multicæcum*, therefore, is the only basis of comparison with those of the present specimens obtained from *Ophicepahlus striatus* collected from Laguna de Bay, Laguna Province. The following description is based on the presently collected specimens. These were flattened, fixed in Bouin's picro-formol, stained in Semichon's carmine and mounted in toto.

EUCLINOSTOMUM MULTICÆCUM Tubangui and Masiluñgan.

Description.—Body elongate, rounded at both ends but much wider anteriorly than posteriorly; measuring from 9 to 12 mm in length by 3 to 4 mm in maximum width. Cuticle unarmed; oral sucker rather weak and terminal, 0.6 to 0.7 mm across; acetabulum well developed, in anterior fourth of body, measuring about 1.4 to 1.43 by 1.39 to 1.47 mm. Prepharynx, rudimentary, about 0.25 to 0.28 mm in length just anterior to the bulblike pharynx, 0.15 to 0.196 by 0.2 to 0.22 mm; oesophagus short, hardly discernible. Intestinal crura rather prominent with long diverticula in postacetabular region extending to the posterior end of the body. Some of the diverticula are forked distally at level of or anterior to the uterine sac, at the level of the testis and also the distal fourth of the body (Plate 1, fig. 5; Plate 2, fig. 2). On either side of the body and emerging from behind the intestinal crura at about the level of the acetabulum are the lateral excretory vessels which extend posteriorly and open into the median, postero-dorsal excretory pore. Reserve excretory system well distributed.

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* Department of Zoology, University of the Philippines Parasitological Collection Nos. 201 and 308.

Testes tandem in the posterior part of the middle third of the body; anterior testis broadly U-shaped, 0.154 to 0.196 by 1.12 to 1.48 mm; posterior testis crescentic with a small knoblike projection directed posteriorly, 0.17 to 0.35 by 0.62 to 0.66 mm; cirrus pouch just above the anterior testis enclosing a coiled vesicula seminalis and a cirrus opening immediately below the uterine sac opening. Between the testis towards the right side of the median line, is the irregularly shaped ovary, 0.168 to 0.238 by 0.084 to 0.126 mm, Laurer's canal present; the much coiled uterine duct occupying the median region between the two testes; after coiling considerably, the uterine duct ascends towards the left about midway between the acetabulum and gonads, then loops downward to form the uterine sac, 1.2 to 1.58 mm long, ending at the uterine opening immediately adjacent to the cirrus opening at the genital atrium (Pate 2, fig. 2, and Plate 3, fig. 5).

Vitellaria profuse, finely granular, postacetabular, occupying all spaces not occupied by other organs.

DISCUSSION

Euclinostomum multicaecum as described by Tubangui and Masiluñgan,(19) is strikingly similar to the specimens herein redescribed except for the following: (*1*) my specimens were immediately set free upon cutting the visceral lining of the fish where as those of Tubangui and Masiluñgan were reported as encysted; (*2*) the forking of the intestinal diverticula is somewhat different; (*3*) the coiling of the uterine duct is not shown in the description of Tubangui and Masiluñgan but was doubtless similar to that noted in this description; and (*4*) the cirrus pouch, together with the vesicula seminalis and cirrus, and the position of the genital atrium were not described. The species described by Tubangui and Masiluñgan probably is identical with the specimen described by me but certain anatomical parts were misinterpreted or not seen.

ACKNOWLEDGMENT

The author is very grateful to Dr. Zacarias de Jesus, College of Veterinary Medicine, University of the Philippines, for his very valuable suggestions; to Dr. George R. LaRue, Agricultural Research Center, Beltsville, Maryland, for going over the manuscript; to Dr. Canuto G. Manuel, deputy commissioner, National Institute of Science and Technology, Manila, for help rendered in the identification of the experimental birds; and to Dr. Benjamin Romero, Malabon, Rizal, for supplying some of the birds.

ADDENDUM

Before this paper went to press and while the author was a Guggenheim Fellow in the United States (1957) her attention was called to Jaiswal's paper on some clinostomids from Indian fishes and birds. *Clinostomum macrocosm* Jaiswal(10) resembles *C. philippinensis* in general anatomy and occurs in the same host, *Ophicephalus striatus*. However, *C. philippinensis* sp. nov. differs in the relative size of the body, relative size of anterior and posterior suckers, relative position of the ovary and the genital pore, and in the character and extent of the vitellaria.

It is also noted that Jaiswal(10) in all his descriptions and illustrations of the clinostomids did not show a pharynx. Baer (1) in his key to the larval forms of clinostomids recognized the presence or absence of the pharynx. Lamont(13) and Yamaguti(22) in their descriptions and illustrations of *C. intermedialis* and *C. complanatum* (Rud., 1819) respectively showed a definite pharynx. LaRue(14) in his classification indicated that this group is pharyngeate. The work of his students, Krull (12) and Edney, (unpublished) indicates the presence of a pharynx. In my species the pharynx is hardly discernible.

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ILLUSTRATIONS

[Abbreviations used: *a.s.*, anterior sucker; *c.*, cuticle; *c.m.l.*, circular muscle layer; *cir.*, cirrus; *cir.p.*, cirrus pouch; *d.m.*, diagonal muscle bundle; *d.v.m.*, dorso-ventral muscle; *e.l.m.*, external longitudinal muscle layer; *ej.d.*, ejaculatory duct; *ex.c.*, excretory canal; *ex.v.*, excretory vesicle; *g.a.*, genital atrium; *g.e*$_1$: preacetabular glandular cell; *g.e.*$_2$, eosinophilic glandular cell; *g.e*$_3$, colorless glandular cell; *i.c.*, intestinal caecum; *i.l.m.*, longitudinal muscle layer; *L.c.*, Laurer's canal; *my.*, myoblast; *oot.*, ootype; *ov.*, ovary; *p.l.m.*, parenchymal longitudinal muscle; *s.v.*, seminal vesicle; *t.a.*, anterior testis; *t.p.*, posterior testis; *uc.*, uterine cell; *u.i.div.*, uterine internal diverticula; *u.s.*, uterine sac; *v.s.*, ventral sucker, *vit.*, vitellaria.]

PLATE 1

[All figures, except Fig. 2, are unretouched photomicrographs.]

FIG. 1. *Clinostomum ophicephali* Tubangui and Masiluñgan 1944. Ventral view.

2. *Clinostomum philippinensis* sp. nov., metacercaria encysted in the eyes of *Ophicephalus striatus* Bloch (Photograph).

3. *Clinostomum philippinensis* sp. nov., metacercaria, flattened and stained. Ventral view.

4. *Clinostomum philippinensis* sp. nov., experimental adult. Ventral view.

5. *Euclinostomum multicæcum* Tubangui and Masiluñgan 1935, metacercaria. Ventral view.

PLATE 2

[Drawn with a photographic enlarger.]

FIG. 1. *Clinostomum philippinensis* sp. nov. Ventral view.

2. *Euclinostomum multicæcum* Tubangui and Masiluñgan 1935. Dorsal view.

PLATE 3

[Unretouched photomicrographs.]

FIG. 1. *Clinostomum philippinensis* sp. nov., horizontal section, showing the glandular cells. (Enlarged portion of Plate 3, fig. 2.)

FIG. 2. *Clinostomum philippinensis* sp. nov., horizontal section at anterior region, showing the anterior sucker, part of the posterior sucker, intestinal cæca, excretory canals, and the relative arrangement of the glandular cells. × 12.

3. *Clinostomum philippinensis* sp. nov., horizontal section of posterior portion, showing part of the posterior testis, vitellaria, excretory canals, and the entrance of the intestinal cæca into the excretory vesicle. × 13.

4. *Clinostomum philippinensis* sp. nov., horizontal section of posterior region, showing the Y-shaped excretory vesicle and the vitelline follicles. × 13.

5. *Euclinostomum multicæcum* Tubangui and Masiluñgan 1935, enlarged portion of the genital complex. × 9.

PLATE 4

[All figures, except Fig. 5, are unretouched photomicrographs.]

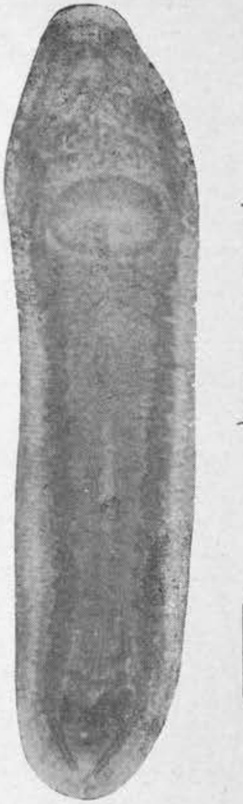
FIG. 1. *Clinostomum philippinensis* sp. nov., horizontal section at the level of the genital complex. × 13.

2. *Clinostomum philippinensis* sp. nov., cross-section at the level of the genital atrium. × 11.5.

3. *Clinostomum philippinensis* sp. nov., showing the entrance of the cirrus into the uterus. × 17.

4. *Clinostomum philippinensis* sp. nov., cross-section, showing the ovary and the Laurer's canal. × 28.

5. *Clinostomum philippinensis* sp. nov., photograph of experimentally obtained adults in the buccal cavity of *Nyticorax caledonicus manillensis* Vigors.



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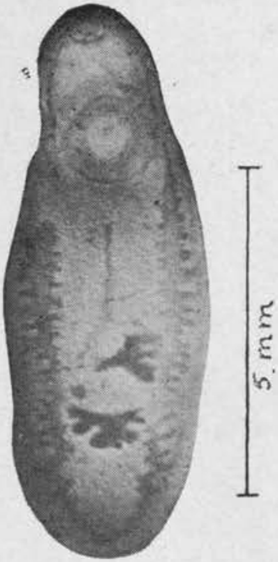

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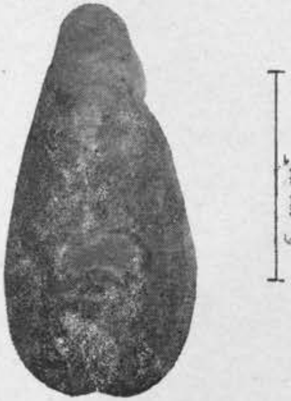

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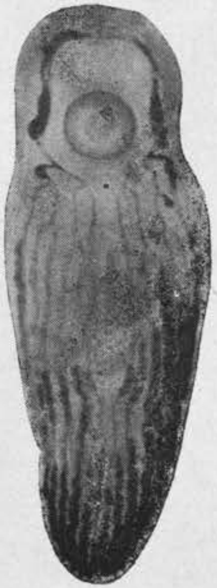

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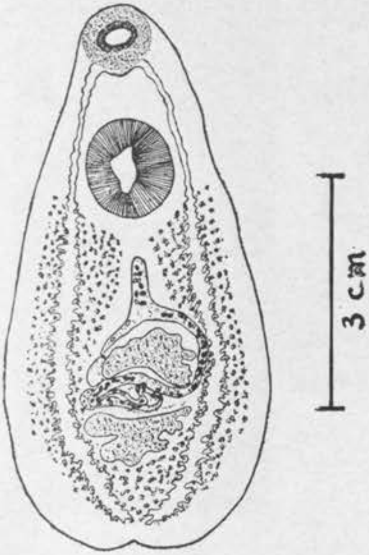

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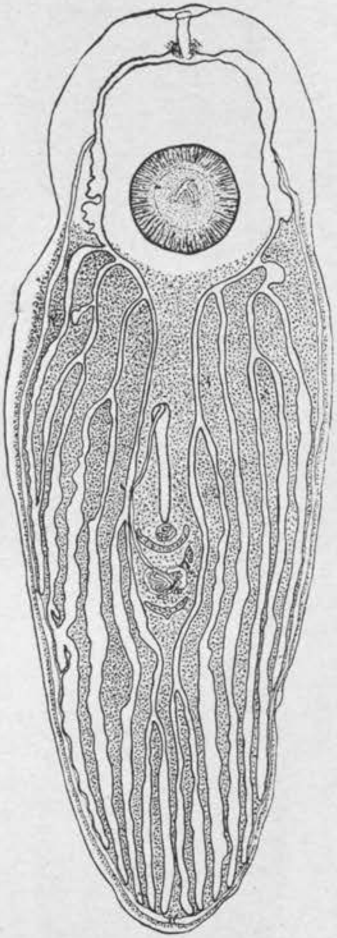

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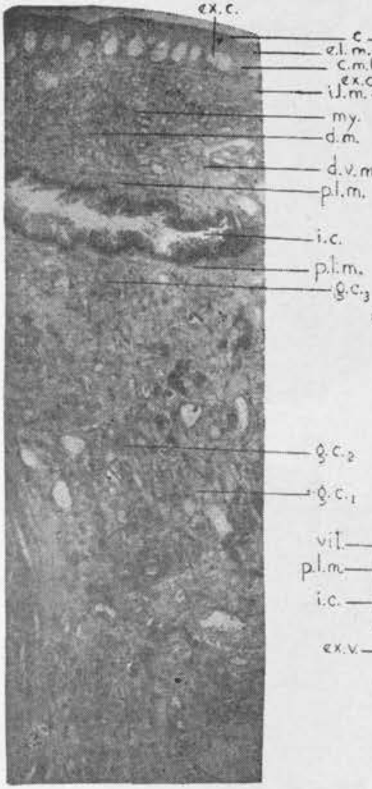
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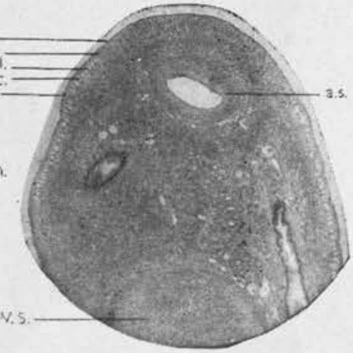
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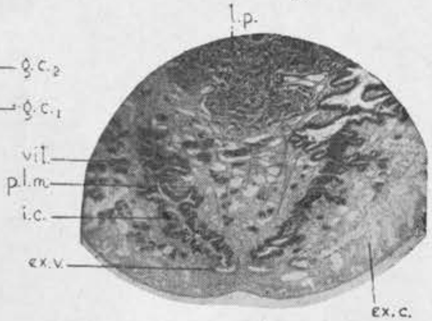
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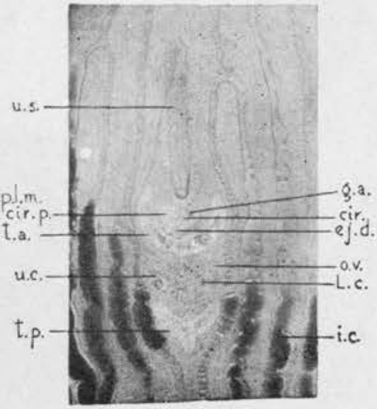
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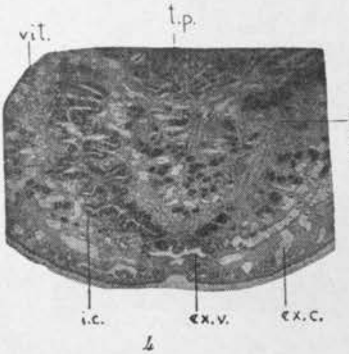
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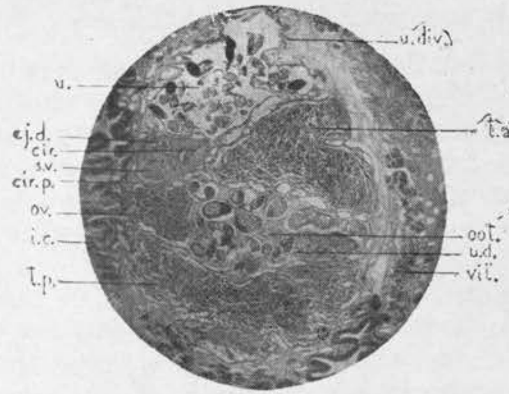
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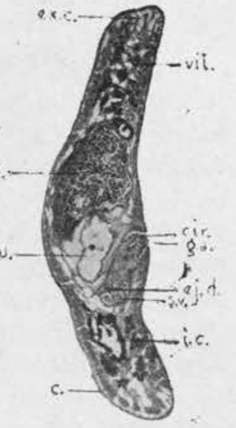
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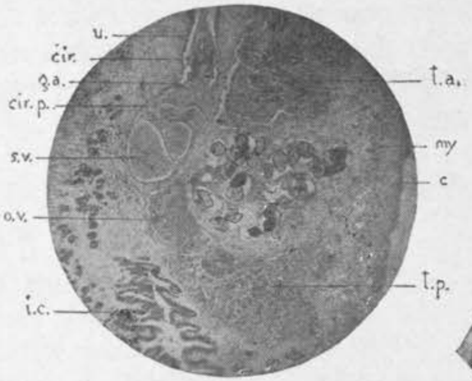
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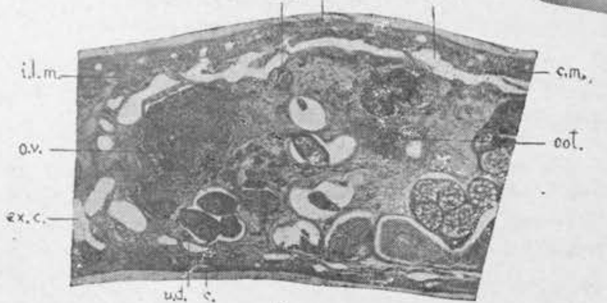
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ON ASIATIC AND RELATED CHRYSOPINÆ (DIPTERA: TABANIDÆ)

By C. B. PHILIP and I. M. MACKERRAS *

ONE PLATE AND SEVENTY-ONE TEXT FIGURES

This work began with three small collections of unusual species from China, which were sent to C.B.P. for study. More material accumulated as it progressed, and we were fortunate to receive several pertinent types on loan. At that stage, the paper was still fragmentary; but we were then able to give it greater coherence by working together on the collections in the British and Paris Museums, where we found, amongst other important material, no less than six species of our new genus *Gressittia*. One of us (C.B.P.) also received assistance from the Marsh Fund of the National Academy of Sciences, U.S.A., which enabled him to examine the specimens in the Artis Natura Magistra (Entomological Museum) in Amsterdam. The end result is a short review of all known species of the Oriental-Malaysian and eastern Palaearctic genera of Chrysopinæ except the ubiquitous *Chrysops*, of which we offer notes on only a few.

We wish to acknowledge our great indebtedness to Dr. T. Y. Cheng, National Taiwan University, Taiwan (Formosa), Mr. K. C. Kim, a Korean biologist now at Montana State University, and Dr. Edward L. Kessel, California Academy of Sciences, who provided the original material; to Dr. Alan Stone, United States National Museum (USNM in later text), Professor J. N. Knull, Ohio State Museum, Columbus, Professor Doctors Max Beier, Naturhistorisches Museum, Vienna, and Fritz Peus, Zoologisches Museum, Berlin, for the loan of types and other critical material; to Dr. S. L. Tuxen, Universitets Zoologiske Museum, Copenhagen, for comparing specimens with the type of *Rhinomyza fusca* Wied. for us, and so solving a difficult problem in identification; and finally, to Mr. H. Oldroyd, British Museum (Natural History) (BMNH), Professor E. Séguy, Muséum National

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d'Histoire Naturelle, Paris, and Dr. C. A. W. Jeekel, Artis Natura Magistra, Amsterdam, for providing us freely with facilities to work in their institutions and loan of some material. All these have contributed materially to make the present review possible.

FAUNAL RELATIONSHIP OF ASIATIC CHRYSOPINÆ

The subfamily Chrysopinæ is divided into three tribes(8): Bouvieromyiini, containing the most generalized species, and distributed predominantly in southern and eastern Africa and in Australia; Rhinomyzini, specialized and aberrant forms, principally developed in Africa and Madagascar; and Chrysopini, predominantly Holarctic, with *Chrysops* radiating through the continents like the eutherian mammals. The first specimens received in the present study included two new Bouvieromyiini, which led us to suspect that an element of Ethiopian origin extended far into China. It seemed possible, too, that this element had been derived from an arc of dispersal which had been shown in other subfamilies to extend around the Indian Ocean.(9) The material studied in London strongly supported both suggestions.

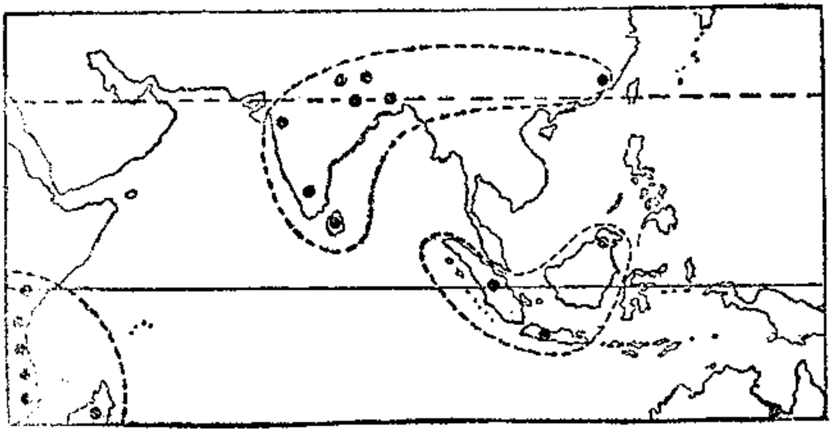


FIG. 1. Distribution of Rhinomyzini. To the west, African-Malagasian genera; center above, *Gastroxides;* to the east below, *Rhinomyza.*

The pattern can be defined by the Rhinomyzini (Fig. 1), because its members are so distinctive that their relationship cannot be doubted. This group is plastic, and different genera are involved; but equally strong evidence comes from the single, more conservative genus *Gressittia* (Bouvieromyiini, Fig. 2), which neatly fills the gap between the genera on either side of it, and marks the pathway into China even more clearly than does *Gastroxides*. The three species, *pulchripennis* from Kenya, *nepalensis* from Nepal, and *birumis* from Central China, form a closely related complex which is not easy to resolve at the specific level.

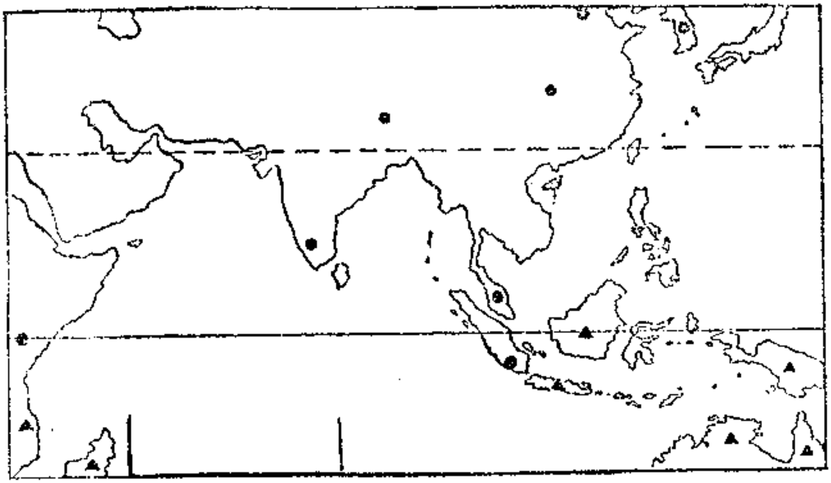


FIG. 2. Distribution of Bouvieromyiini. Solid spots, *Gressittia;* circle, *Thaumastomyia* in the north; triangles, African-Malagasian genera to the west, *Eucompsa* in Java and Borneo, Australasian genera to the east.

Another new genus, *Thaumastomyia,* is even more remote in N. China and Korea. Its relationships point in two directions. On the one hand, it is so close to African *Mesomyia* that it is debatable whether it should be given generic or subgeneric status, and it consequently provides evidence that is independent of *Gressittia*. On the other hand, it shows several points of resemblance to *Merycomyia,* suggesting that the ancestors of that peculiar eastern American genus probably entered North America by the Behring arc, rather than from the south.

If the remarkable resemblance between *Chrysops longicornis* Macq. of Africa and *C. grandis* (Szil.), to be discussed later, does indicate recent origin from common ancestors, then a much later element will have followed the same path, and carried the intrusion to Taiwan.

The distribution of *Silvius* (Fig. 3) is in almost complete contrast with those discussed above. It lies in a long line across Asia north of the Tropic, with an upward trend at the eastern end into Japan and at the western end into Europe. Even our new species from northern Burma does not distort the line, although its close resemblance to the European *S. singularis* (Meig.) is puzzling. Only *S. ceylonicus* Szil., from Ceylon, is out of place. The latter, on loan, is a true *Silvius*, with evident Palaearctic affinities, and is known from a single specimen collected nearly a hundred years ago. If the record can be trusted, it probably represents a reverse migration, a phenomenon that has been encountered elsewhere, for example, between New Guinea and Australia.

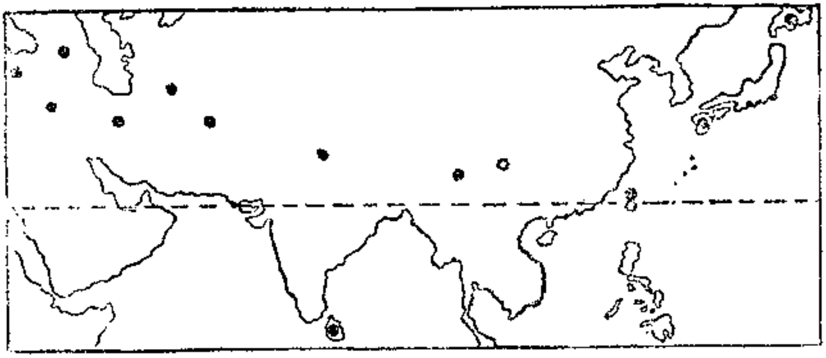


FIG. 3. Distribution of *Silvius*. Solid spots, subgenus *Silvius*; circles, subgenus *Neosilvius*.

The Ethiopian intrusion has contributed a small but significant element to the faunal structure of the Chinese Tabanidæ; but we believe that it is basically much more important, because it defines a pathway by which the ancestors of the Chrysopini could have reached the northern land masses, where they evolved as a major tribe. There are several lines of evidence to support this suggestion:

1. Morphological studies have indicated that the Chrysopini evolved from generalized Bouvieromyiini.(7, 8) *Silvius* is the lowliest member of the Chrysopini, and it merges into the more specialized northern genera of the tribe.
2. No present-day forms that might represent precursors of *Silvius* have been found in the Americas. There are only "*Veprius*" (of authors, not Rondani, a subgenus of *Mesomyia*) in the south, and the aberrant *Merycomyia* in the north. These seem to be rather feeble offshoots from purely bouvieromyiine stock, although they could be relicts of a more varied fauna that died out in the Tertiary.
3. On the other hand, generalized Bouvieromyiini are strongly developed in southern Africa. They have radiated widely, and there is no morphological reason why *Silvius* should not have evolved from the

Mesomyia-Perisilvius complex. *Silviomyza*, in Ceylon, is in a critical position on the arc of distribution, and it may be significant that its classification in Chrysopini rather than Bouvieromyiini is primarily a matter of convenience. The two bouvieromyiine genera in China did not develop from the same line of evolution as *Silvius;* they represent collateral lines which were probably contemporaneous.

4. The Chinese group of *Silvius* here segregated as the subgenus *Neosilvius* is, in many ways, the most primitive part of the genus, particularly in antennal structure, shape of palpi, practical absence of frontal and facial calli, and closed anal cell. It is, in fact, distinguished from Bouvieromyiini, not so much by tribal characters, as by its evident relationship to typical northern *Silvius*.

Thus, the home of *Silvius* could have been in eastern Asia, which spread westward to the Mediterranean, and eastward by the former Behring bridges into western North America, where it developed its most successful, modern burst of speciation. It may also have returned south to Ceylon. There is no morphological reason why the other genera and subgenera of the tribe should not have arisen from the same ancestral stock.

To summarize, we visualize the Chinese and neighboring chrysopine fauna as composed of four elements: ancient relicts (*Thaumastomyia, Gressittia*) derived from Africa; locally developed *Neosilvius* and *Silvius;* more recent invaders (*Gastroxides, Chrysops grandis*) of African origin; and a preponderance of modern *Chrysops*, some of Palaearctic and others of recent Oriental derivation. Neither of the other subfamilies of Tabanidæ in the area presents such a complete picture, the local Pangoniinae being exclusively ancient, and the Tabaninæ essentially modern.

A comparison of the known tabanid faunas of Taiwan(16, 17) and the Philippines(13) supports the belief of Dickerson, et al.(2) that the separation of the Philippines from the continent (and probably from Taiwan) is of great antiquity (pre-Vigo-Miocene), although there are temperate Asiatic floral and faunal relicts on Luzon highlands to indicate an ancient connection. The success of such vigorous northern derivatives as the *Tabanus amaenus* complex and species of *Atylotus* and *Hybomitra* in colonizing Taiwan, and their failure so far as is known, to become established in Luzon, would seem to confirm the much longer isolation of the latter island, on which Gressitt

(5) also comments in discussing its zoogeography. In the Chrysopinæ, *Gastroxides* was probably too recent, and the more southern arc represented by *Eucompsa* too weak, to have reached the Philippines, but *Silvius* may well have been old enough, and we would not be surprised if a species were found in the islands. That none has been discovered so far may simply be due to rarity and cryptic habits, perhaps combined with isolation in high country.

Key to the Asiatic and Indo-Malayan genera of Chrysopinæ

1. Antennæ biramous; vein sc setulose below; abdomen of ♀ tapering to a point; usually large (13 to 18 mm), dark species 2
   Antennæ simple, dorsal angle of third segment obtuse or rounded; vein sc bare; abdomen of ♀ truncate 3

2. Antennal scape more than twice as long as thick; palpi of ♀ swollen and shiny. (India, Ceylon, China) .... *Gastroxides* Saund.
   Antennal scape little longer than thick; palpi of ♀ flattened, pollinose. (Indonesia and Malaya) .... *Rhinomyza* Wied.

3. Eyes densely hairy; subcallus large, bulging; antennæ very small, with swollen scape and short, biannulate style (Fig. 6). A large (19 mm) dark species, with wide frons, swollen parafacials, and hairy pollinose face. (N. China and Korea) .... *Thaumastomyia* gen. nov.
   Eyes at most microscopically hairy; subcallus small, not markedly inflated; antennæ longer, with tri- or quadri-annulate style 4

4. Antennæ shorter than thickness of head, scape and pedicei short, subtriangular or rounded (Figs. 22, 37, 52), style tri- or quadriannulate 5
   Antennæ longer than thickness of head, scape and pedicel clearly longer than wide, subcylindrical (Figs. 49, 57, 67), style quadriannulate 7

5. Antennal style slender, quadriannulate; wing with characteristic dark pattern (Plate 1, figs. 1–6); frons of ♀ with well defined, elongate callus. (Kenya, India, Nepal, Central China, Malaya, Sumarta) *Gressittia* gen. nov.
   Antennal style shorter, usually triannulate; wing with or without pattern; frons of ♀ entirely pollinose, with at most a rudimentary callus 6

6. Frons of ♀ converging strongly towards antennæ; palpi swollen on basal half; wing fumose or strikingly spotted (Plate 1, fig. 7); larger (12 to 15 mm), darker species. (Java, Borneo) .... *Eucompsa* End.
   Frons of ♀ parallel or diverging toward antennæ; palpi slender; wing at most yellowish in costal area; small (8 to 10 mm), pollinose, yellow species. (Central China, Taiwan) *Silvius* (*Neosilvius* subgen. nov.)

7. Large (17 mm), beelike flies, with very large, shiny ocellar tubercle; all tibiæ greatly swollen; wings diffusely brown anteriorly. (Northern India) .... *Melissomorpha* Ric.
   Smaller (8 to 12 mm) species, not beelike; ocellar tubercle limited to

upper fourth or less of frons; at most fore tibiæ moderately swollen; wings variable 8

8. A medium-sized (12 mm), dark brown fly; with long, slender palpi; short, soft proboscis; long, brownish wings, darkened anteriorly; and bare, rather shining, unpatterned abdomen. (Ceylon) *Silviomyza* gen. nov.

Usually smaller (8 to 11 mm), more slender, paler or patterned species, with usually shorter, thicker, palpi, longer, more rigid proboscis, clear or strongly patterned wings, and pollinose or patterned abdomen 9

9. Yellowish, pollinose species; wings clear, or darkened in costal and adjacent cells only (Plate 1, fig. 9); anal cell usually closed; antennæ not much longer than thickness of head; eyes in life usually "freckled" with small spots. (Japan, Taiwan, central China, northern Burma, northern India, Ceylon) .... *Silvius* (*Silvius* Meig.)

More strongly patterned species; wings with well-defined dark pattern (Plate 1, figs. 10, 11); anal cell usually open; antennæ usually much longer than thickness of head; eyes in life with larger, usually angular spots. (Cosmopolitan) .... *Chrysops* Meig.

Tribe BOUVIEROMYIINI

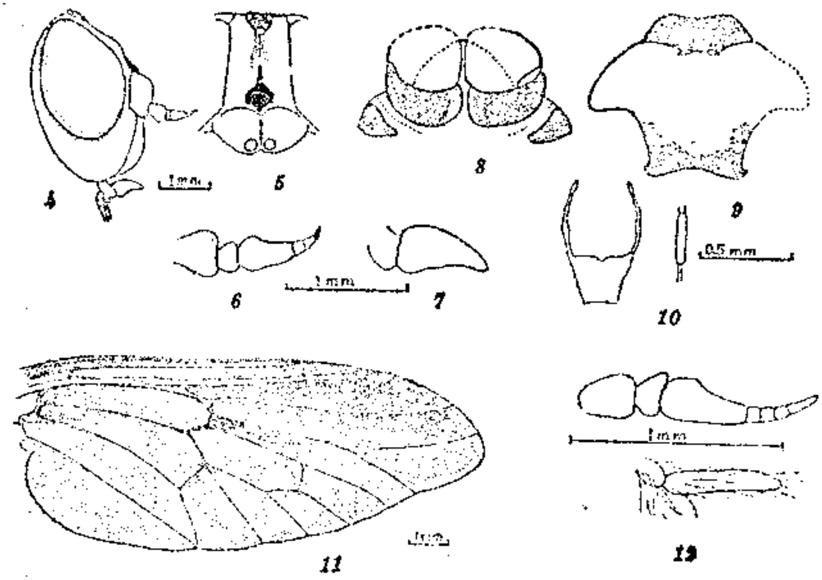
Genus THAUMASTOMYIA novum

Genotype: *Merycomyia haitiensis* Stone, N. China, monotypic. (Figs. 4 to 11)

This remarkable, hairy-eyed fly belongs to the *Mesomyia* complex, and we thought at first that it was undescribed. However, C.B.P. subsequently saw the type of *haitiensis* in USNM, realized that it was the same as our species from Korea, and found that the locality Hatien is not in the Caribbean area but a suburb of Peiping, China. We had also thought that we could include it in the subgenus *Pronopes* Loew, as redefined by Oldroyd [(1957) 204–210]. However, examination of the types of *Mesomyia* (*Pronopes*) *flavipes* Hine, very kindly lent to us by Professor J. N. Knull, showed that there are substantial differences, and subsequent study of the extensive collection of African species in the British Museum demonstrated that *Thaumastomyia* also diverges considerably from the other subgenera. We have therefore given it generic rank.

Female.—A large, dark, hairy but only slightly pollinose fly, with clouded, parchmentlike wings. Eyes densely hairy; without revivable pattern; ocellar tubercle and ocelli large; frons moderately wide, diverging, pollinose, with small isolated callus; subcallus inflated, but normally differentiated from frons; parafacials and occiput inflated; antennæ very short, with scape markedly swollen, basal plate of flagellum rounded dorsally, and style biannulate; palpi short, thick, conical, pollinose; proboscis short and soft, with fleshy labella. Fore and mid tibiæ distinctly swollen; hind tibiæ without detectable spurs. Wings with vein sc bare above and below; R_4 without appendix; cells R_5 and M_3 widely open, anal cell closed. Genitalia normal for the tribe, the distinguishing features being the large lateral "wings" of the eighth sternite, which is unpigmented except for the gonopophyses and base, and the short, wide, very pale caudal ends of the spermathecal ducts.

Male.—Unknown.



Thaumastomyia (gen. nov.) *haitiensis* (Stone).

FIG. 4. Profile of head; 5, frons; 6, antenna (from a cleared preparation); 7, palp; 8, terminal segments and cerci; 9, eighth sternite and gonopophyses; 10, furca and caudal end of spermathecal duct; 11, wing; 12, *Gressittia nepalensis* sp. nov., ♂ antenna and palp.

Thaumastomyia is to be distinguished from the hairy-eyed subgenera of *Mesomyia* by much larger size, markedly inflated occiput, subcallus, parafacials and antennal scape, swollen tibiæ, absence of hind tibial spurs, and patterned wings; and from the subgenus *Pronopes* (with which it agrees in having a biannulate antennal style) also by the normal relationship between frons and subcallus, much shorter, more fleshy proboscis, and inflated palpi. There are points of resemblance to the Nearctic genus *Merycomyia*, which also includes large flies, with reduced antennal segments, short, thick palpi, and reduced hind tibial spurs; but they have bare eyes, smoother bodies, uninflated subcallus and parafacials, differently shaped antennæ, and (at least in the genotype) rather different genitalia. Nevertheless, the two genera probably diverged from common ancestral stock.

THAUMASTOMYIA HAITIENSIS (Stone), comb. nov.

Merycomyia haitiensis STONE, Jour. Wash. Acad. Sci. 43 (1953) 255.

A moderately large, dark, flattened, shaggy, smoky-winged fly, with small head, short antennæ, palpi and proboscis, and no detectable spurs on hind tibiæ.

Female.—19 mm. Postocular rim wide, with even, ridge-like hind margin, and heavy row of yellow hairs. Ocelli large, on a prominent, dark brown tubercle; the post-vertex unusually bulbous, margined by two deep sulci; frons soft and wrinkled, wide, moderately divergent, index 1.5, yellow to sooty pollinose, with rather dense black hairs; callus (Fig. 5) small, isolated from margins, shining black, with a tapering median extension about half way to anterior ocellus. Subcallus inflated, sparsely yellow-brown pollinose, without hairs. Face and cheeks dirty buff gray, with mixed shaggy yellow and black hairs; the cheeks swollen, apodemal pits slitlike, deep. Antennæ (Figs. 4, 6) unusually short, about equal to the metatarsus, reddish yellow; scape swollen and thicker than the remaining segments, pedicel not half as long, neither dorsally produced, both with shaggy black hair; basal plate of flagellum about as long as scape and pedicel together, dorsal angle rounded; style biannulate, the terminal annulus darker on its apical half, which may give the impression of a third annulus in uncleared specimens. Palpi (Fig. 7) unusually short and chunky, the basal segment bulbous, the apical segment swollen basally and tapered to a blunt point, covered with coarse black hairs. Proboscis short, dark, fleshy, but little longer than the palpi, the labella large and longer than the theca.

Scutum and scutellum dull yellowish, with four broad, dark lines, and a dark shadow on disc of scutellum; covered with mixed black and yellow hairs. Pleura and chest yellowish, with dark hair. Fore coxæ swollen, mostly yellow-haired. Legs dull reddish; the femora heavy, the fore and mid tibiæ perceptibly swollen; covered with coarse black hairs, no hind tibial fringe.

Wing (Fig. 11) with yellow-tinted, parchmentlike membrane, smoky basally in the basal and radial cells, around the crossveins, and along the hind margin including the apex; veins at base of cell M_3 constricted to a point; subepaulets small and somewhat inflated, covered with fine, yellow microtricheæ but no setæ. Halteres with yellowish stems and collapsed, smoky knobs.

Abdomen dark brown, with a basal, grayish-white, divided band on fourth tergite; mostly black-haired, with yellow hairs in a median patch on first tergite and sparsely on the following incisures; fourth tergite with wide, pale-gray, pollinose basal band divided in the middle. Venter dull reddish, with a broad, dark, median stripe, mostly black-haired. Genitalia (Figs. 8 to 10): eighth sternite with dark gonopophyses and darkly chitinized base, almost membranous elsewhere, including the wide lateral wings; ninth tergite a pair of widely separated, triangular plates; tenth divided, large, darkly chitinized; cerci broken at tip; furca with long, narrow arms, as is usual in the subfamily; caudal ends of spermathecal ducts short and wide, but pale and not easy to see, tapering abruptly into the unarmed portion of the ducts.

CHINA: Hatien (near Peiping) type ♀ in USNM. KOREA: Seoul, May 27, 1957 (*K. C. Kim*); in the collection of C. B. Philip, through the courtesy of the collector, who has taken many insects of several orders in the vicinity of Seoul.

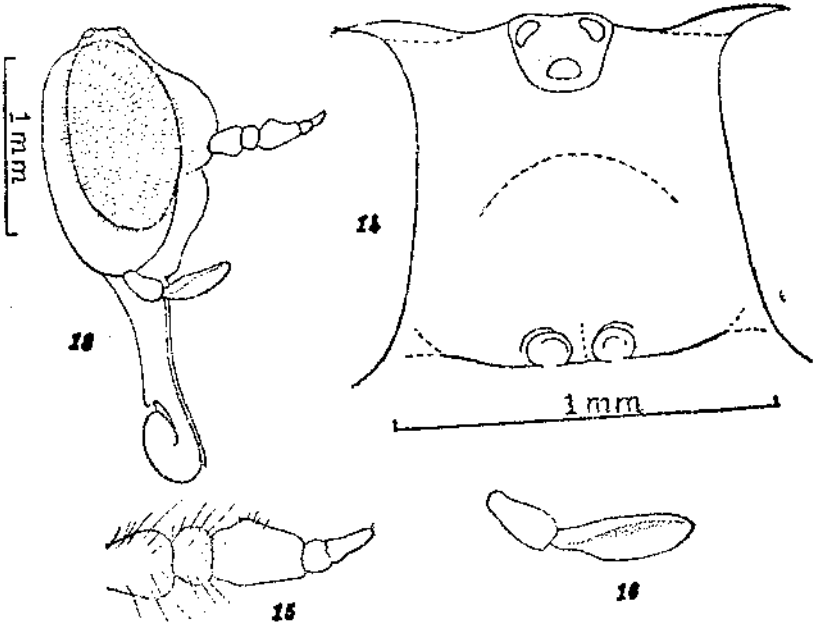
The fly was apparently recently emerged, and the body and wings are somewhat crumpled; the colors may be duller than in life. It is, however, so distinctive as to warrant description as a new genus in the absence of more perfect material.

The types of *Mesomyia* (*Pronopes*) *flavipes* Hine (Figs. 13 to 16).

Oldroyd(10) noted that Hine(6) had not indicated the location of his types. The three original specimens, from Cape Province, South Africa, are in the Hine collection in the Department of Entomology, Ohio State University, Columbus, U.S.A. They had no type labels, but the description was based primarily on the males published as type and paratype. At Professor Knull's request, one of the two males has now been selected and labelled as lectotype. Oldroyd had males of the original series on loan from Vienna Natural History Museum.

Males can be identified from Oldroyd's description and figure, but the allotype is the only female known in the subgenus, and it is therefore desirable to amplify Hine's brief description of it.

Female.—A small (8 mm), smooth fly, with thorax humped somewhat like a simuliid in profile, glassy wings, and globose abdomen. Eyes widely separated, somewhat bulbous, hairy; occiput swollen behind eyes, but no defined postocular rim; ocellar tubercle and ocelli unusually large. Frons pollinose, without indication of callus, and merging, without defined line of separation, into the very large, swollen subcallus (Figs. 13, 14), so that it is impossible to define a frons index; face flat, with sparse hairs; parafacial sutures indistinct, but apodemal pits unusually large, deep, and circular. Antennæ (Fig. 15) with scape not swollen, pedicel beadlike, basal plate of flagellum with rounded dorsal angle, and style biannulate (Hine was mistaken in regarding the flagellum as having the normal five annuli). Palpi (Fig. 16) as in male, porrect, blunt, not swollen, and with lateral sensory grooves. Proboscis about two-thirds height of head, with small, smooth labella. Legs robust, but fore and mid tibiæ not swollen; hind tibial spurs about as large



Mesomyia (Pronopes) flavipes Hine, ♀
FIG. 13. Profile of head; 14, frons; 15, antenna; 16, palp.

as those on mid tibiæ. Venation normal; tegulæ and squamæ unusually small; subepaulets small, somewhat inflated, bare. Genitalia not dissected.

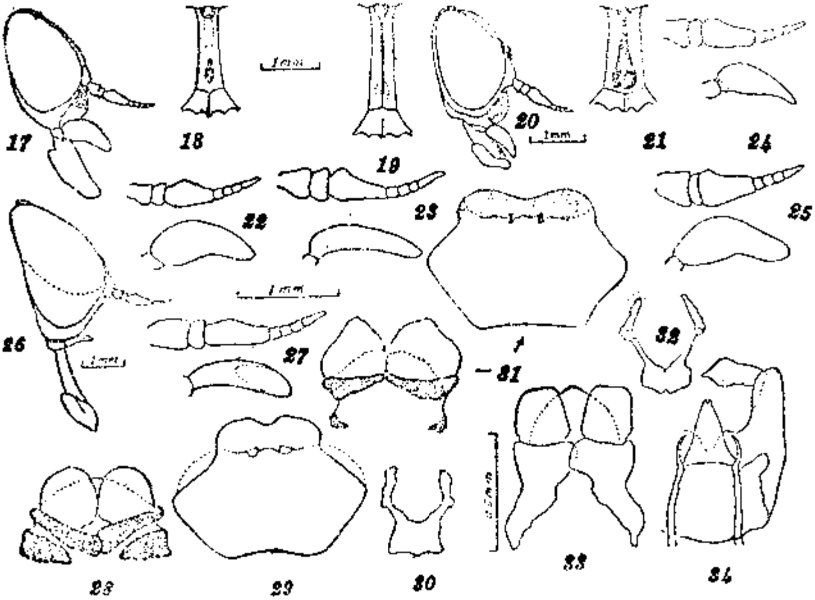
Genus GRESSITTIA novum

Genotype: *Gastroxides fuscus* Schuurmans Stekhoven, 1926, Malaya, by present designation. (Figs. 17, 18, 22; 28–30, 33–34; Plate 1, fig. 2.)

Female.—Moderately slender to robustly built, rather bare flies. Eyes rounded, bare, without indications of banding in relaxed specimens. Frons medium to narrow (index 2.5 to about 6), slightly diverging, with elongate, sometimes linear callus. Subcallus normal, pollinose; parafacials narrow, thinly pollinose; face protuberant, rounded, bare, shining. Antennæ slender, scape and pedicel small, basal plate of flagellum with obtuse or rounded dorsal angle, style slender, quadriannulate. Palpi laterally compressed, usually short and wide in lateral view, firm, pollinose. Proboscis short, with large, fleshy labella. Propleural lobes hemispherical, usually prominent. Hind tibial spurs very small or absent. Wings with a distinctive pattern of two dark bands (Plate 1, figs. 1–6); vein sc bare above and below; R_4 sometimes angulate, but without appendix; cells R_5 and M_3 widely open, anal cell closed. Terminal segments of abdomen dorsoventrally compressed; genitalia normal for the tribe.

Male.—Head large (Fig. 26); eyes bare, holoptic; upper facets markedly enlarged and clearly differentiated from the small lower and posterior facets. Ocellar tubercle prominent, projecting above level of eyes. Face entirely pollinose, rather deeply recessed between the wide, bulging, pollinose, parafacials. Antennæ more slender than in female. Palpi with second segment subcylindrical or somewhat spatulate, slightly curved, with or without apical lateral bare area. Genitalia (Figs. 33, 34) normal for the tribe.

This genus is distinguished in Bouvieromyiini by the wing pattern, virtual absence of hind tibial spurs, and the bulging, shining face of the female. It shows several points of resemblance to the Rhinomyzini, for example, in the bare, subshiny body and *Tabanocella*-like wings, which led Schuurmans Stekhoven (14) into error in placing two of the species; but it lacks antennal or genital specialization, and it has no setulæ on sc, which all known Rhinomyzini possess. It may have come from that part of the bouvieromyiine stock from which the Rhinomyzini arose. It is dedicated to Dr. J. L. Gressitt whose studies on zoogeography of the Pacific area are well-known, and who collected one species (*birumis*) in a primitive faunal area in Central China.(4)



Gressittia gen. nov., heads, frons, antennæ, palpi, ♂ and ♀ genitalia.

Fig. 17, 18, 22, 28-30, *G. fusca* (Sch. Stk.), ♀: 33, 34 ♂ genitalia of same; 19, 23, *flava* sp. nov., ♀: 20, 21, 24, 31, 32, *birumis* sp. nov., ♀: 25, *apicalis* sp. nov. ♀: 26, *media* sp nov., ♂ (broken line is the division between large and small facets): 27, *aterrima* (Sch. Stk.), ♂.

Key to species of Gressittia

1. Robust, uniformly dark brown species, with entirely dark scutellum, and yellowish tarsi contrasting with the dark brown tibiæ and femora 2

   Smaller or paler species, with the tarsi not contrastingly paler than the other segments 3

2. Tibiæ markedly swollen; a larger (15 to 16 mm) species. (Malaya) .... *aterrima* (Sch. Stk.) (♂ ♀)

   Tibiæ not obviously swollen; a somewhat smaller (12 to 14 mm) species. (Malaya) .... *media* sp. nov. (♂)

3. Dark brown species, with at least part of the scutellum conspicuously pale 4

   Paler species, with bright, yellow-brown scutum, concolorous scutellum, and at least first and second abdominal tergites yellowish 6

4. A small (8.5 mm), delicate species, with almost whole scutellum pale, and first three abdominal segments reddish. (Nepal)
nepalensis sp. nov. (♂)
Larger (12 mm) species, with at most apical half of scutellum whitish, and all abdominal segments dark 5

5. Pleura, legs and abdomen entirely brown. (Central China)
birumis sp. nov. (♀)
Pleura with gray tomentum and hairs; apices of tibiæ and tarsal segments reddish; first and second abdominal tergites with narrow reddish apical bands. (Kenya) .... [*pulchripennis* (Aust.) (♂)]

6. Wing (Plate 1, fig. 6) with sharply defined pattern, and large, clear apical spot in cell R_4; antennal plate (Fig. 25) relatively wide. (India) .... *apicalis* sp. nov. (♀)
Wing (Plate 1, fig. 2) with less sharply defined pattern, and at most vaguely paler in cell R_4; antennal plate more slender (Figs. 22, 23) 7

7. Smaller (10 to 12 mm) species, with tibiæ markedly darker than femora; females with short, oblong callus, and shorter, wider palpi. (Malaya) .... *fusca* (Sch. Stek.) (♂ ♀)
Larger (11 to 14 mm) species, with tibiæ little darker than femora; females with linear callus and narrower palpi. (Sumatra).
flava sp. nov. (♂ ♀)

GRESSITTIA BIRUMIS sp. nov.

A moderately slender, smooth, dark, medium-sized species, with elongate callus, slender, reddish yellow antennæ, widely white-margined scutellum, and dark brown legs. It differs from *pulchripennis* in the absence of any, even reduced, paler banding on abdomen and legs, entirely brown pleura, entirely dark hairs on head, body and appendages, and wider pale margin to scutellum.

Holotype ♀, 11 mm. Frons brown pollinose, with narrow buff margins next to the eyes, gently divergent below, index 2.5; callus dark brown, ovoid, swollen, wider than tall, and merging broadly above into a median, flattened, brown extension, which tapers to the ocellar tubercle; short, black, upright hairs at the vertex continue laterally as a margin along a moderate, gray-pollinose postocular rim. Subcallus brown pollinose. Face shiny, dark brown; parafacials and cheeks sooty brown pollinose, with sparse black hairs. Antennæ (Fig. 24): scape and pedicel yellowish brown, with sparse black hairs; flagellum reddish yellow, the apical annulus brown, plate with rounded dorsal angle. Palpi brown, sparsely black-haired. Proboscis black, about as long as the face.

Body and legs dark chocolate brown, with short, sparse, black hairs, the humeral lobes above the anterior spiracles pale yellow, and a wide, whitish, pale-haired, apical band on the scutellum. The propleural lobe on each side in front of spiracles subshiny brown, unusually distinct and globose (hence the fanciful specific name, "double-breasted"). Tibiæ a little lighter towards the knees. Wing (Plate 1, fig. 1) fumose apically, a broad hyaline band across the basal and anal cells, two pale spots in the radial sector beyond the stigma, and the hind margin paler; remainder, including costal cell, brown. Squamal tuft sparse, white. Halteres brown. Genitalia distinguished by the unusually wide, shallow gonopophyses (Fig. 31).

CHINA, West Hupeh, Lichuan District, Suisapa, alt. 3,300 feet, July 22, 1948, (*Gressitt* and *Djou*); in the California Academy of Sciences; taken incidental to the Dawn-Redwood Expedition in an environment where trees of ancient lineage have survived.(4)

GRESSITTIA NEPALENSIS sp. nov.

A small, delicate, brown species, with pale scutellum. Differentiated from *birumis* and *pulchripennis* by (presumably) smaller size, dark antennal style, outer hyaline band on wing less restricted and completely separating the apical from the middle dark band, and reddish basal abdominal segments. The small tuft of hairs on the tegula is golden yellow in *nepalensis*, white in *birumis*.

Holotype ♂, 8.5 mm, wings 10 mm. Head wider than thorax; enlarged facets of the eyes occupying a little more than half the total area, the occipital band of small facets extending to the vertex and a little wider than in related species. Ocellar tubercle prominent, brown. Frontal triangle, face and cheeks deep yellow pollinose; beard sparse, dark yellow. Antennæ (Fig. 12) slender, yellowish red; style darker and equal to the plate in length; the latter about twice as long as high, slightly excavated dorsally. Palpi slender, cylindrical, deep yellow, with concolorous and a few brown hairs; the apical segment about four times as long as thick, slightly curved, and with a blunt tip.

Body worn dorsally. Scutum and last four abdominal segments dark brown, without evident pattern. Scutellum pale yellow, indistinctly darker basally. Propleural lobes bulbous and prominent. Pleura and first three abdominal segments reddish, the vestiture golden yellow, with some darker hairs caudally on the abdominal sternites. Legs uniformly brown, with mostly black hairs, but with yellow ones on the fore coxæ; tibiæ not swollen; hind tibial spurs not evident. Wings (Plate 1, fig. 5) with hyaline interval between the apical and middle dark bands wider than in related species, occupying the space between the fork of R_{4+5} and a line joining the outer ends of the stigma and the discal cell.

Female.—Unknown.

EAST NEPAL, Arun Valley, alt. 3,500 feet, June 13, 1954 (*L. Swan*); in the California Academy of Sciences.

GRESSITTIA PULCHRIPENNIS (Austen), comb. nov.

Silvius pulchripennis AUSTEN, Proc. Zool. Soc. Lond. 107 B (1937) 289, ♂.

This species is still known only from two males from Kenya (Trans-Nzoia District, alt. 6,200 feet); in BMNH. Oldroyd [(1957) 239] allotted it to *Mesomyia* (*Perisilvius*), with the note that it was of doubtful affinities and isolated geographically from other species of the subgenus. It falls naturally into *Gressittia*, and, indeed, is closely related to *birumis* and *nepalensis*, being distinguished only by the comparatively minor characters noted in the key and under those species. The wing pattern [Oldroyd (1957) Plate 12, fig. 2] is very like that of *birumis*, but the hyaline interval between the two dark bands is more sharply defined and scarcely interrupted along vein R_{4+5}.

GRESSITTIA ATERRIMA (Schuurmans Stekhoven), comb. nov.

Gastroxides aterrimus SCHUURMANS STEKHOVEN, Treubia, Suppl. 6 (1926) 60, ♂ ♀.

The ♀ and ♂ syntypes were stated to be in Raffles Museum, Singapore. We understand that they were sent to Kuala Lumpur, for relative safety, during the war. Recently we found the male in BMNH with note that it had been presented by the Federated States Museum, Kuala Lumpur. There was a second male, from Fraser's Hill, May 20, 1936 in excellent condition, but the female was not found. That is unfortunate, as the description was primarily of the female.

A large (15 to 16 mm), dark species; with brown antennæ; thorax, including scutellum, uniformly dark brown; brilliant white squamal tuft; tarsi, particularly mid and hind, and apices of tibiæ yellow, in contrast to the rest of the swollen, brown tibiæ and brown femora; hyaline interval between middle and apical brown bands on wing narrow (Plate 1, fig. 3); and abdomen bright to deep brown.

Female.—Apparently darker than the male, both thorax and abdomen being described as uniformly black-brown. Frons moderately narrow (index about 4); callus oval, with long, narrow, black extension. Face prominent, shining black; cheeks dull, dark brown, with black-brown hairs. Tibiæ incrassate, as in the male.

Male.—Large facets occupying about two-thirds of eye, small facets reaching vertex as a narrow occipital margin, but no evident post-ocular rim. Ocellar tubercle brown. Frontal triangle, subcallus, parafacials and face with brown pollen, which is darker in certain lights, and thinner margining the deep parafacial sutures; hairs, including beard, dark brown. Antennæ (Fig. 27) slender, bright brown. Palpi as long as shaft of proboscis, falcate, dark brown, with blackish brown hairs, and a lateral bare area occupying more than half of the second segment. Proboscis dark brown, labella about as long as theca. Propleural lobes prominent, rounded. Hind tibiæ with anterior spur very short, posterior doubtfully detectable. Wing with elongate hyaline area between R and Rs, two subapical hyaline spots in first basal cell, most of second basal cell hyaline, and the hyaline interval between the apical and middle brown bands extending from apex of stigma to apex of discal cell, but not reaching fork of R_{4+5} distally. Abdomen bright brown on most of basal tergites, darker, with dark brown hairs, apically and laterally; venter bright brown basally, becoming darker on fourth and subsequent sternites; genitalia with style more slender than in *fusca*, otherwise similar.

MALAYA: Negri Sembilan, alt. 2,000 to 2,700 feet; Pahang, Fraser's Hill, alt. 4,000 feet; type ♂ in BMNH (here designated lectotype).

GRESSITTIA MEDIA sp. nov.

Male.—A dark brown species, close to *aterrima*, and best defined by its differentiating features. It is smaller, 12 to 14 mm; palpi (Fig. 26) shorter, with bare area limited to apical third of second segment; tibiæ not incrassate, and scarcely invaded by yellow apically; fore tarsi with yellowish coloration limited to first segment; hind tibial spurs subequal in length, about as long as anterior spur of *aterrima;* hyaline interval between middle and apical brown bands of wing wider, extending distally to fork of R_{4+5} (Plate 1, fig. 4); vein R_4 more or less angulate, but without appendix; and venter with apical fringes of creamy white hairs on second to fourth or fifth sternites.

Female.—Unknown.

Holotype ♂, from Malaya, Pahang, Camerons highlands, alt. 4,000 to 4,500 feet, June 21, 1935 (*H. M. Pendlebury*), in BMNH; three paratype males from same locality (4,500 to 5,000 feet) in the same collection.

GRESSITTIA FUSCA (Schuurmans Stekhoven), comb. nov.

> *Gastroxides fuscus* SCHUURMANS STEKHOVEN, Treubia, Suppl. 6 (1926) 61, ♀.

The headless type is in BMNH, having had a similar history to the type male of *aterrima*. There are two other females and a male in the same collection, so an adequate description can be given of this genotype.

A small-medium (10 to 11 mm), bright yellow-brown species, with uninflated tibiæ considerably darker than femora, and hyaline band separating middle and apical brown bands of wing not extending anteriorly beyond R_{2+3}.

Female.—Frons narrow (index 4.5), slightly divergent below, yellow-brown pollinose (Fig. 18); ocellar tubercle large, prominent, dark brown; callus rather inconspicuous, brown, oblong, limited to lower half of frons, but possibly prolonged by two parallel ridges towards ocellar tubercle. Subcallus and parafacials yellow-brown pollinose, parafacials and cheeks with mixed brown and yellow hairs; beard sparse, yellowish; face moderately bulging (Fig. 17), shining, yellowish and bright brown. Antennæ (Fig. 22): scape and pedicel light yellow, with short brown hairs; basal plate yellowish, becoming brown apically, with very obtuse dorsal angle; style brown. Palpi laterally compressed, bright brownish yellow, with short yellow hairs. Proboscis with bright brown theca and large, dark brown labella.

Scutum and scutellum bright yellowish brown, with short golden hairs; humeral and notopleural lobes paler; pleura bright brownish yellow, with golden hairs; squamal tuft creamy yellow; propleural lobes not as prominent as in *birumis*.

Legs: Coxæ bright yellow, with creamy yellow hairs; femora yellow, becoming brownish distally, with golden hairs; tibiæ and tarsi dark brown, with dark brown to blackish hairs.

Wing (Plate 1, fig. 2): A narrow hyaline area between R and Rs; first basal cell only faintly darkened, second clear, the middle brown band slightly invading their distal ends; hyaline interval between middle and apical brown bands moderately wide, almost reaching fork of R_{4+5} but restricted anteriorly, there being only a trace of paler membrane anterior to R_{2+3} Veins bright yellow at base, including base of R, brown more distally; R_4 without appendix. Halteres with yellow stems and brown knobs.

Abdomen: The tergites are almost uniformly yellow-brown in the type, but it has evidently faded, as it was originally described as "Bright ferrugineous, dark blackish at apex." The following description is based on one of the other females. First and second tergites bright yellow, becoming slightly brownish across disc of second, with bright yellow and some brown hairs; third and subsequent tergites dark to blackish brown, narrowly paler along incisures, and with dark brown hairs. Venter with first sternite and sides of second yellowish, mahogany to blackish brown elsewhere, with apices of sternites paler, and predominantly golden hairs basally, dark brown distally. Genitalia as illustrated (Figs. 28–30); gonopophyses narrower and deeper than in *birumis*.

Male.—Similar to female in general coloration and markings, but the abdomen only darkened slightly on the distal tergites and not at all on the sternites. Enlarged facets covering upper three-fourths of eyes, almost as dark as the lower facets, which extend in a narrow occipital band to the vertex; there is no postocular rim. Parafacials and face entirely pollinose, bright brownish yellow, with golden hairs. Palpi light yellow, sickle-shaped, with bare area inconspicuous (the head is pressed against the mount, and the palpi and mouth parts are difficult to see clearly). Genitalia with large, stout styles (Fig. 34), otherwise normal.

MALAYA, Selangor, Semangko Pass, alt. 2,700 feet, March (type), and Bukit Kutu, alt. 3,300 to 3,500 feet (*A. R. Sanderson, H. M. Pendlebury*); type ♀ in BMNH.

GRESSITTIA FLAVA sp. nov.

A bright yellow and brown species, distinguished from *fusca* by larger size, linear callus in the ♀, more sharply angulate antennal plate, almost entirely yellowish legs, and the hyaline interval between the middle and apical brown bands of the wing extending forward to the costa.

Holotype ♀, 14 mm. Head as in *fusca*, except that the callus (Fig. 19) is linear, and extends from just above the subcallus to the ocellar tubercle; antennæ (Fig. 23) longer, with a sharp dorsal angle, plate yellowish only at base, bright brown distally, and style darker brown; palpi much narrower, more brownish, and with short brown hairs. Thorax as in *fusca*. Legs: femora bright yellow, with yellow hairs; tibiæ and tarsi only slightly darker, but with short dark brown hairs. Wing with both basal cells almost entirely clear, and hyaline interval between the brown bands moderately wide, much as in *G. media* (Plate 1, fig. 4), but not reaching the costal margin so clearly, and the outer brown band as dense as the inner. Abdomen as in *fusca*, except that all sternites are predominantly dark to blackish brown.

Allotype ♂, 14.5 mm. Similar to ♀, and differentiated correspondingly from ♂ of *fusca*. Further characterized by the antennal plate being very long and narrow; palpi short, clavate, with brown hairs; and first three abdominal tergites more diffusely reddish brown, merging into darker color apically.

WEST SUMATRA, holotype ♀ from Benkoelen, Moeara Tenam, alt. 1,200 feet, June, 1935, and allotype ♂, also from Benkoelen, but from Tandjang Sakti, alt. 1,800 feet; in BMNH.

A second ♀, from West Sumatra, Siberut I., September, 1924, in the Natural History Museum, Basle, is provisionally allotted to *flava;* but differs in smaller size (12 mm), shorter callus, rounded dorsal angle of antennal plate, wider, more pointed palpi, darker legs, and entirely yellow first and second abdominal sternites.

GRESSITTIA APICALIS sp. nov.

A bright yellowish species, with a linear callus, and a distinctive wing pattern.

Holotype ♀, 13 mm, not in good condition, but sufficiently distinctive to describe. Head: Differs from *fusca* in having a linear callus almost full length of frons (eyes have collapsed inwards, and an accurate frons index cannot be given); shorter, entirely orange antennal plate and style (Fig. 25); and bright orange-yellow beard. Thorax as in *fusca*. Legs (fore pair and a hind femur only): femora brown, with a yellowish tint, and yellow and brown hairs; tibiæ blackish brown, with black hairs; tarsi somewhat lighter brown. Wing (Plate 1, fig. 6) distinctive by reason of division of the hyaline interval into two parts by a brown band along R_{4+5} and an apical clear spot almost filling cell R_4. In one wing, there is an incipient oval paler spot in the dark distal part of cell R_3. Abdomen: bright yellow-brown, darkening somewhat apically, and with predominantly yellow hairs both dorsally and ventrally.

INDIA, Nilgiri Hills, alt. 3,000 feet, April 4, 1888 (*G. F. Hampson*); in BMNH.

Genus EUCOMPSA Enderlein

Female.—Medium-sized to large (12 to 15 mm), ornate species, with conspicuously banded abdomen, and spotted or fumose wings. Eyes bare, without indication of banding in dried specimen; postocular rim very narrow; ocellar tubercle small, situated on vertex. Frons (Fig. 36) wide (index less than 2), strongly converging, completely pollinose, without callus; subcallus gently rounded, not sharply marked off from frons, pollinose; parafacials and face pollinose and hairy, parafacials narrow, sutures deep, but apodemal pits inconspicuous, face truncate. Antennæ (Fig. 37) short; scape and pedicel small; plate with subbasal dorsal angle; style triannulate. Palpi stout on proximal half, tapering sharply, with indications of a dorsolateral bare area. Proboscis short, with large, firm labella. Scutum and abdominal tergites with dense, unusually strong, bright hairs which form the conspicuous body pattern of the flies. Hind tibial spurs smaller than mid, but well developed. Wing with sc bare above and below; R_4 gently curved, without appendix; cell R_5 widely open, M_3 slightly narrowed, Cu_2 closed, short-petiolate. Terminal abdominal segments depressed; genitalia (Fig. 38) without distinctive features.

Male.—Unknown.

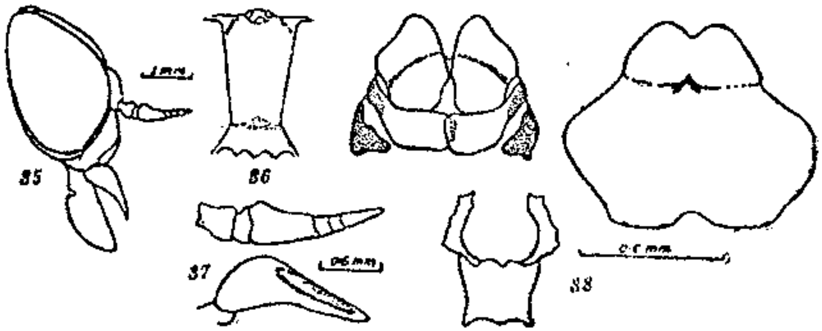
This genus is clearly related to the Papuan members of the tribe. It is distinguished from *Mesomyia* (*Pareucompsa*) by wider frons, absence of a callus, different wing pattern, and striking pattern of hairs on the body; and from the Papuan species included in *Mesomyia* (*Pseudotabanus*) by Mackerras(8) also by the triannulate antennal style. This group of flies, *Eucompsa, Pareucompsa* and Papuan *"Pseudotabanus,"* stands apart from the bare-eyed Bouvieromyiini of the mainland of Australia, and resembles the African-Malagasian fauna, especially *Aegophagamyia*, in the shape of palpi and absence of setulæ on sc. It seems possible that the subgenera of *Aego-*

phagamyia and the Papuan-Indonesian groups evolved at opposite ends of a formerly continuous arc of distribution, of which the middle section is now lost, but its position indicated by the distribution of *Gressittia*. Whether the true, Australian *Pseudotabanus* developed from this line, or from southern *Mesomyia* stock, is still uncertain.

EUCOMPSA AUREOCINCTA Enderlein.

Eucompsa aureocincta ENDERLEIN, Mitt. Zool. Mus. Berl. 11 (1925) 319, ♀. Genotype species: Figs. 35–38; Plate 1, fig. 7.

Through the kindness of Prof. Dr. Fritz Peus, we have been able to examine the type female. It is a moderately large (15 mm), golden yellow species, with a narrow black band across the scutum, a black, crescentic band covering much of scutellum, brown legs, strikingly pictured wings (Plate 1, fig. 7), and the abdominal tergites banded dark brown and golden yellow.



Eucompsa aureocincta End., ♀

FIG. 35. Profile of head; 36, frons; 37, antenna and palp; 38, genitalia.

Female.—Frons slightly less than twice as tall as its width at mid length (index 1.8), fawn-yellow; subcallus somewhat paler; parafacials and face yellowish cream, with pale yellow hairs, which are dense on parafacials. Antennæ: scape and pedicel fawn-yellow, with pale yellow and a few brown hairs; flagellum bright orange. Palpi yellow, becoming brownish distally above, with bright yellow hairs. Proboscis with bright brown theca and darker brown labella.

Scutum with underlying integument dark gray to blackish, but completely hidden by dense covering of rich golden yellow hairs, except for a black, pollinose, transverse bar and a small brown patch above wing-roots. Scutellum dark brown, with black hairs, on basal three-fourths, light yellow, with golden hairs, apically. Pleura pale yellow to grayish, with long golden hairs.

Legs brown, with golden to bright brownish hairs; apical tarsi darker.

Wing: Costal cell brown, radial area diffusely yellowish, remaining ground color light brownish; three dark brown patches, one across apices of basal cells and along Cu_1, the second across apex of discal cell, and the third at apex of wing but leaving hind margin clearer and a darker spot at fork of R (Plate 1, fig. 7).

Abdomen: First tergite brownish yellow, with golden hairs; second to fifth brown, with dark brown hairs, and broad, light brown, densely golden-haired, apical bands, widening slightly in the centers of the tergites; sixth and seventh entirely brown, with predominantly dark brown hairs, but a few golden ones apically and centrally. Venter bright brown, with pale fawn apical bands on the sternites, and broad, dark brown, basal bands on second and third; hairs predominantly yellow. Cerci appear tentlike in end view.

EAST JAVA, Tengger Mt., alt. 4,000 feet, (*Fruhstorfer*).

Eucompsa tecticallosa Schuurmans Stekhoven [Arch. Naturg. n.f. 1 (1932) 59], ♀, from Borneo, apparently differs from *aureocincta* in smaller size (12 mm), black-brown tibiæ and tarsi, and diffusely brownish wings.

Tribe RHINOMYZINI

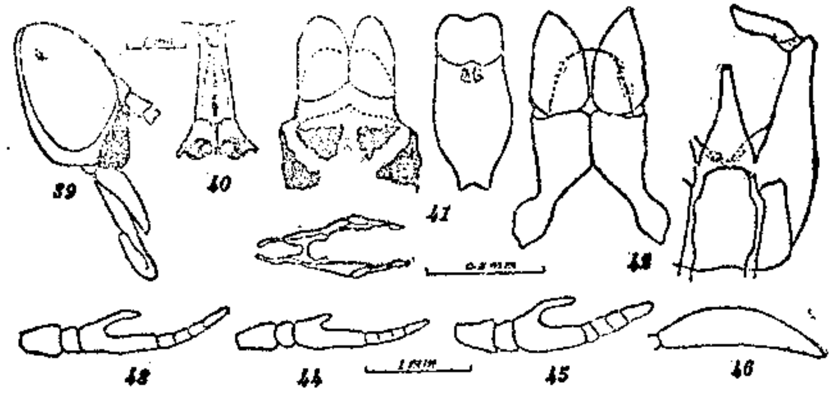
Genus GASTROXIDES Saunders

This genus has already been re-defined [Mackerras (1955) 627–8, fig. 25; Oldroyd (1957) 140–1, fig. 83]. Points of immediate concern are: in both sexes, the long antennæ, with markedly elongate scape and pedicel; in the female, the ocellar tubercle at a somewhat depressed vertex, wide, wrinkled frons, with bulging callus, narrow, shining parafacials, shining buccæ, conspicuously bulging, polished face, and inflated, shiny palpi; in the male, the distinctly convex, shining face. Sexual dimorphism is marked.

We recognize three species: *ater* (Saunders) the genotype, from India; *ornata* (Bigot), from Ceylon; and *shirakii* Ôuchi, from Fukien Province, China. We have not seen the last, but Ôuchi's(11) description and figure suggest that his insect was more probably a *Gastroxides* than a *Rhinomyza*. Of the three species described by Schuurmans Stekhoven,(14, 15) one (*atricinctus*) is transferred to *Rhinomyza*, and the other two (*fuscus, aterrimus*) belong to *Gressittia* (Bouvieromyiini).

Genus RHINOMYZA Wiedemann

Close to *Gastroxides*, and exhibiting equally marked sexual dimorphism, but differing in the following respects. Female: Ocellar tubercle well below vertex (Fig. 40); frons narrower (index about 3), smoother, thinly pollinose, and without callus. Parafacials and buccæ wider, thinly pollinose; face narrower and less protuberant, shining, but not highly polished; antennæ shorter, with much shorter scape and pedicel (Figs. 39, 45); palpi flattened, pollinose. Male: Antennæ as in the female; face deeply recessed, entirely pollinose, unlike the protuberant, shining one on *Gastroxides*. Eyes bare, vein sc setulose below, and R_4 without appendix in both sexes. The male and female genitalia (Figs. 41 to 42) are essentially similar to those of *Gastroxides*, except that the style of the male is more like that of the African *Sphecodemyia*.



Rhinomyza Wied.

FIGS. 39–41, *R. fusca* Wied., ♀, head, frons, genitalia (furca with posterior end to right); 42, 43, ♂ of same, genitalia, antenna; 44, *oculata* sp. nov., ♂, antenna; 45, 46, presumed ♀ of *oculata*, antenna and palp.

Rhinomyza is less specialized than *Gastroxides*, and its lack of differentiating features tends to link it with the African *Hinea* and *Tabanocella*. Transfer of the West African *H. rodhaini* (Beq.) and *H. praestabilis* (Grünb.) to *Rhinomyza*, as suggested by Oldroyd [(10) and in discussion], would leave *Hinea* reasonably compact; but there is still an interesting anomaly in *T. fenestrata* Séguy, from Madagascar, which has a pointed, *Rhinomyza*-like abdomen in the female. This is essentially an adaptive character, which may have evolved independently so we would leave *fenestrata* in *Tabanocella*, and retain the four genera as distinct until the Oriental species are better known.

Key to the Indonesian species of Rhinomyza

1. Males 2
   Females 4
2. Dorsal antennal tooth long (Fig. 43); pale portions of wings yellowish; yellowish bands of third and fourth abdominal tergites wide, rather diffuse .... *fusca* Wied.
   Dorsal antennal tooth short (Fig. 44); pale portions of wings grayish or clear 3
3. Wing without pale spot at fork of R_{4+5}; abdomen with orange bands enclosed by black on third and fourth tergites .... *oculata* sp. nov.
   Wing with pale spot at fork of R_{4+5}; abdomen with yellowish band on third tergite, fourth and subsequent tergites blackish brown. *atricincta* (Sch.Stk.)
4. A larger (15 mm), brown and yellowish species, with the pale areas on the wing yellowish, and a broad yellowish band embracing the first and basal fourth of the second abdominal tergites *fusca* Wied.[*]
   A smaller (13.5 mm), blackish species, with the pale areas on the wing grayish, first abdominal tergite entirely black, and a narrow whitish basal band on the second .... ?*oculata* sp. nov.

RHINOMYZA FUSCA Wiedemann.

Rhinomyza fusca WIEDEMANN, Nov. Dipt. Gen. (1828) 8, ♂. Genotype species by monotypy. (Figs 39–43; Plate 1, fig. 8.)

The tribe Rhinomyzini was founded on a monotypic genus, which was known from only a single male, collected more than 130 years ago, and never studied by any modern worker. We found two species of *Rhinomyza* in the British Museum, both agreeing with Wiedemann's description well enough to raise doubts as to which might be the true *fusca*. Dr. Tuxen kindly solved this important problem by comparing males of both with Wiedemann's type from Batavia, Java, in the University Zoological Museum, Copenhagen. He reported that the larger species "agrees exactly with Wiedemann's type of *R. fusca* in every detail, whereas the specimen determined by Oldroyd as *fusca* is another species."

A relatively large (14 to 15 mm), predominantly brownish species, with long antennal tooth, pale areas of wing distinctly yellowish, and male with first, third and fourth abdominal tergites predominantly yellowish, and narrow, creamy, basal bands on second to fourth tergites.

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[*] A fourth species near *fusca* from Selangor, Malaya, which differs in chalk-white sternite and upper pleural lobes, will be described by Philip, Malaysian Parasites, XXXV (1960), in press.

Male.—Head wider than thorax; eyes with upper facets markedly enlarged, dull yellowish in a broad zone adjacent to the small facets, reddish black over central area; an occipital margin of small, dark facets ending just below vertex. Frontal triangle, subcallus and parafacials brown, pollinose, with brown hairs; face similar; beard dark brown. Antennæ (Fig. 43): scape and pedicel brown, with black hairs; basal plate of flagellum bright brown basally and on dorsal tooth, darkening to blackish brown apically and on style. Palpi dark brown, with dark brown hairs.

Scutum and scutellum brown, with predominantly bright brown hairs, darkening to blackish brown on lateral margins; apical margin of scutellum reddish. Pleura brown, with brown hairs, except for conspicuously bright yellow, yellow-haired upper mesopleural convexity.

Legs dark brown, becoming blackish on tarsi; hairs dark brown to black.

Wing (Plate 1, fig. 8) with two broad brown bands, which restrict the light yellowish ground color to a triangular area at the base of the wing and an oblique band extending across the middle of the wing from R_{2+3} to Cu_1; there is a paler spot at fork of R_{4+5}, and the apical and posterior area behind vein R_4 is lighter brown than the dark band basal to it. Veins bright yellowish on pale areas, more yellowish brown on darker parts. Halteres with yellowish stem, and conspicuous, bright creamy yellow knob.

First abdominal segment above and below, bright yellow, with bright yellow hairs, somewhat darker and with brown hairs centrally, narrowly paler on hind margin; second tergite entirely dark brown, with dark brown hairs, except for a narrow, well-defined, yellowish cream basal band; third and fourth predominantly yellowish brown, with black hairs, a variable, narrow, yellowish cream basal band, and broader, dark brown apical band and lateral margins; remaining tergites blackish, with black hairs, variably yellowish brown at apical lateral corners. Venter predominantly blackish behind first sternite, with black hairs, except, for narrow, yellowish cream basal bands on second and third. Genitalia as in Fig. 42.

WEST JAVA, Preanger, Djampang Tenggah, May, 1935, 5 ♂ in BMNH.

Female.—This specimen lacks antennal flagella, but it agrees with the males so well in size and appearance that the association is probable. Frons (Fig. 40) medium (index 3), somewhat wrinkled, brown, with variable fawn-brown reflections; a small, rubbed, central area towards lower end, but no definite callus. Subcallus paler than frons, except lateral to insertions of antennæ; parafacials (Fig. 39) narrow above, widening below, covered with thin pollen, which varies from yellowish fawn to brown with changing incidence of light; face dark brown, shining above, but not highly polished, and with median and lateral, thinly pollinose patches at lower margins; beard sparse, blackish brown. Antennæ: scape and pedicel brown to yellowish brown, with short black hairs. Palpi (Fig. 39) relatively slender, dark brown, with dark brown hairs.

Scutum somewhat lighter brown than in male, and with predominantly yellowish hairs on disc. Legs as in male. Wings more yellowish than in male, the basal cells infuscated in basal halves only, the central brown band narrower and extending backwards only into cell M_3, and the apical clouding more vague.

Abdomen with first tergite predominantly bright yellow, with yellow hairs, brown at base laterally; second black, with black hairs, a pale yellowish cream band basally, and very narrowly paler along apical margin; remaining tergites entirely black, with black hairs, and a brownish tint at apical lateral corners of some segments. Venter similar to dorsum, except that the base of the first sternite is entirely brown. Genitalia as in Fig. 41.

SUMATRA, Tannangtalu, May, 1915 (*E. Jacobson*), in the Artis Natura Magistra, Amsterdam.

RHINOMYZA OCULATA sp. nov.

Rhinomyza fusca Oldroyd (1957) 141, *nec* Wiedemann.

This species, which had been recorded by Oldroyd before the males described above were received, is sufficiently close to *fusca* to be defined by its distinguishing features.

Holotype ♂, 13 mm. Smaller and more compactly built than the male of *fusca*. Eyes larger, hemispherical; upper large facets entirely blackish, without paler zone bordering the small facets. Antennal tooth short (Fig. 44). Upper mesopleural convexity with a conspicuous, rounded, orange-yellow spot; scutellum perceptibly darker than notum, without reddish apex;

pale areas on wing grayish, without yellow tint. First abdominal segment above and below entirely orange; orange areas on third and fourth tergites enclosed in black margins on all sides and not reaching the upper, outer corners as in *fusca*.

NORTH BORNEO, Bukit Kretam area (*J. D. H. Hedley*); in BMNH.

We doubt whether the female from Java (Loa Tabach) in BMNH, which Oldroyd (10) tentatively associated with the male, really is conspecific with it, and we therefore do not designate it as allotype. It is 11.5 mm and almost entirely blackish; with frons and subcallus ashy pollinose; antennal plate yellowish brown basally, tooth relatively long (Fig. 45); palpi relatively wide and pointed (Fig. 46); humeral lobes, lateral margins and dorsocentral lines on scutum brownish; upper mesopleural convexity whitish; and second abdominal tergite with a narrow, whitish, basal band, the rest of the abdomen being entirely blackish.

RHINOMYZA ATRICINCTA (Schuurmans Stekhoven), comb. nov.

Gastroxides atricinctus SCHUURMANS STEKHOVEN, Zool. Jahrb. 54 (1932) 430, ♂.

The type of this species has been seen by C. B. P., and there is no doubt that it is a *Rhinomyza*. The eyes have a pale rim of large facets, as in *fusca*, and the first abdominal tergite is yellowish. The short antennal tooth would ally it with *oculata*, but it differs considerably in wing and abdominal patterns. The type in USNM was from Buitenzorg (Bogor), Java.

Tribe CHRYSOPINI

Genus MELISSOMORPHA Ricardo

This genus is still based on a remarkable, single female of *M. indiana* Ricardo [Proc. Zool. Soc. Lond. (1906) 93] from near Darjeeling, northern India. Examination of the type in BMNH has confirmed the suggestion [Mackerras (1955) 589] that it belongs to Chrysopini, antennal scape being twice as long as wide, pedicel longer than wide, plate of flagellum long and narrow, and style quadriannulate. Except for considerably longer plate, the proportions of segments are not unlike those of *Silvius dorsalis* in Fig. 60. Other external characters agree, including shape of the body, which is quite different from the bouvieromyiine bee-mimic, *Dasycompsa*, of Africa. The type locality is little south of the line of distribution of *Silvius* in Fig. 3.

Genus SILVIOMYZA novum

Genotype: *Silvius piceus* SZILÁDY, 1926, Ceylon, monotypic. (Figs. 47–50.)

Female.—A smooth, dark fly of medium build. Eyes bare, without pattern in dried specimen. Frons moderately wide, diverging below, with protuberant callus; subcallus short but wide, pollinose, not clearly separated from frons; parafacials swollen, shining; face shining, with pollinose patches in center and below the deep apodemal pits. Antennæ (Fig. 49) separated at base; scape swollen, about twice as long as wide; pedicel longer than wide; basal plate of flagellum slender, rounded dorsally; first segment of style large, remainder missing. Palpi long, slender, flattened, with blunt apex. Proboscis short, fleshy, with large labella; mandibles normally developed. Thorax, including pleura, entirely pollinose; propleural lobes normal. Hind tibial spurs well developed. Wings fumose, darker anteriorly; vein sc bare above and below; R_4 with appendix; cell R_5 widely open, M_3 a little narrowed at margin, anal cell closed. Abdomen bare, somewhat shining, without pattern; terminal segments dorsoventrally compressed; genitalia without distinctive features.

Male.—Unknown.

This fly is unusually difficult to place tribally. It resembles Chrysopini in its short, wide subcallus, shiny face marked with pollinose patches, length and proportions of the antennal segments, and the presence of an appendix on R_4. These characters are easy to define, and it is therefore convenient to include it in that tribe. On the other hand, it resembled Bouvieromyiini strongly in general habitus, coloration, palpi and proboscis; female genitalia, too, suggest relationship with Bouvieromyiini rather than with Chrysopini.

Study of male genitalia and eye pattern in life might be conclusive. Szilàdy described the eyes as dark brown, with an oblique, oval spot in the middle. They now show vague indications of blackish and dark bronzy brown mottling, but these may be due to discoloration, and it was not thought wise to risk damaging the unique specimen by attempting to revive any original pattern that may have been present.

Whether or not our present allocation ultimately proves to be correct, there is no doubt that this is a primitive insect which shows a definite trend towards the Chrysopini. Confirmation of its occurrence in Ceylon would therefore be of considerable zoögeographical importance.

SILVIOMYZA PICEA (Szilady), comb. nov.

Silvius piceus SZILÀDY, Biol. Hung. (7) 1 (1922) 4, ♀.

The type female, received through the kindness of Professor Max Beier, is in good condition, except that it lacks the terminal annuli of the antennal style and both mid legs. Szilàdy's description and figures are not completely accurate.

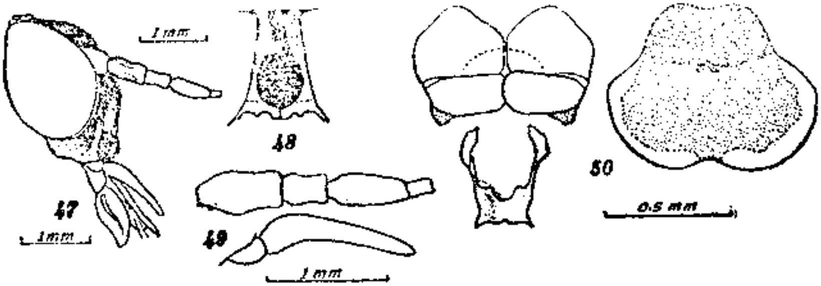
A medium-sized (12 mm), brown species, which, in addition to the generic characters, is distinguished by the contrasting, pale yellow posterior half of scutum and scutellum, long, brownish wings, darkened in costal and radial areas, and uniformly brown legs.

Female.—Eyes rounded; occiput somewhat concave in dorsal view. Frons medium (index 1.8), blackish and rather wrinkled on upper half and laterally, with small, almost indistinguishable, dark brown hairs; ocellar tubercle raised, dark brown; callus (Fig. 48) shining dark brown, bulging forward, almost full width of frons at base, irregularly heart-shaped, and merging into a rather vague extension to anterior ocellus. Subcallus yellow-brown, pollinose. Parafacials and face entirely shining brown, except for narrowly pollinose ocular margin, a triangular, dull yellowish, median patch extending upwards from oral margin, and a bright yellow pollinose patch at lower lateral aspect of each apodemal pit, merging into duller pollen on lower cheeks; hairs brown, limited to lower cheeks, where they merge into the short, rather sparse, brown beard. Antennæ (Fig. 49): scape rather shining dark brown, with dark brown hairs; pedicel less shining, with similar hairs; basal plate of flagellum blackish brown, paler at base; basal annulus of style blackish brown. Palpi pollinose, dark brown, with brown hairs. Proboscis dark brown, with a vague, sclerotized, lateral band on labella.

Anterior half of scutum dark brown, with traces of darker median and paler dorsocentral lines, slightly paler humeral lobes, and dark brown hairs; a little less than posterior half of scutum and all of scutellum strongly contrasting, pale creamy-yellow, with pale yellow hairs. The margin between the two colors is irregular, and there is a yellow patch extending anteriorly to the upper posterior corner of each notopleural lobe, and a dark patch above each wing base. Pleura brown, with dark brown hairs.

Legs almost uniformly dark brown, with dark brown hairs.

Wings brownish, costal cell and radial area beyond fork of Rs diffusely but distinctly darker; stigma dark brown; veins deep brown to blackish; R_4 angulate, appendix longer in one wing than the other. The median cross-vein closing the discal cell distally is defective on one wing, being represented only by short stumps arising from M_2 and M_3.



Silviomyza picea (Szil.), ♀

Fig. 47. Profile of head; 48, frons; 49, antenna and palp; 50, genitalia.

Abdomen rather shining, dark brown, with posterior margins of tergites narrowly slightly paler; hairs uniformly dark brown. Venter similar, except for an elongate, pale brownish-gray, pollinose patch, bearing long, rather paler hairs, on each side of first sternite. Genitalia (Fig. 50): eighth sternite rather lightly chitinized, with indefinite margins and large gonophyses; tenth tergite scarcely sclerotized; cerci short and wide; furca and caudal ends of spermathecal ducts normal for subfamily.

CEYLON: 1861 (*Felder*); in Vienna Museum. No other specimens have since been recorded, but there seems to be no reason to doubt the correctness of the locality.

Genus SILVIUS Meigen

Eight species of *Silvius* are now known from Asia east of 75° E, including the two described below as new. Most appear to be rare, and very few specimens are available, so that it is still impossible to give a satisfactory account of them. We hope, simply, that these notes will provide a basis for future study of this interesting group.

Key to the species of Silvius of the Far East

1. Antennal scape and pedical short (Fig. 52), style often triannulate; R_4 usually without appendix; frons and face pollinose, female at most with a rudimentary frontal callus. (Subgenus *Neosilvius*) 2

Antennal scape twice as long as wide, style quadriannulate (Figs. 57, 60); R_4 usually with appendix; frons, and often face, with prominent, shining calli. (Subgenus *Silvius*) 3

2. Tibiæ dark brown, in contrast to yellow femora; thoracic integument and pollen yellow. (Taiwan) .... *formosiensis* Ric. (♀ ♂)

Legs unicolorous, tibiæ but little darker distally; thoracic integument dark, the pollen olive-yellow. (Central China) *suifui* sp. nov. (♀ ? ♂)

3. Abdomen with symmetrical dark pattern 4

Abdomen without contrasting pattern 6

4. Face entirely pollinose; abdomen with series of dark transverse bands. (Northern Burma) .... *ornatus* sp. nov. (♀)

Face with paired, bare calli; abdominal pattern otherwise 5

5. Abdomen with short black macule in middle of first two tergites. (Northern India) .... *indianus* Ric. (♀)

Abdomen with transverse bands on tergites 4 to 5, dark thereafter. (Taiwan) .... *shirakii* nom. nov. (♂)

6. Size small (9 mm); face and parafacials widely bare, shining yellow. (Ceylon) .... *ceylonicus* Szil. (♂)

Size larger (over 10 mm); face pollinose, with paired, dark, shining, rounded calli 7

7. Facial calli surrounding apodemal pits; wings tinged yellowish; callus of female large, filling more than half of frons. (Japan) *dorsalis* Coq. (♀ ♂)

Facial calli smaller and situated above the pits; wings clear; callus of female less than half the frontal area. (Japan) *matsumurai* K. & T. (♀ ♂)

Subgenus NEOSILVIUS novum

Subgenotype: *Silvius formosiensis* RICARDO, 1913, Taiwan (Formosa), by present designation.

Female.—Small, yellowish, pollinose species. Eyes bare; those of genotype described by Shiraki (16) as brilliant green with coppery reflections in life; both species show possible suggestions of small purple "freckles" when relaxed. Frons and face almost entirely pollinose, at most a rudimentary frontal callus; antennæ bouvieromyiinelike, with short scape, beadlike pedicel, unusually short, wide plate (at least in subgenotype), and triannulate style; palpi slender, curved. Wing venation generalized (as in Plate 1, fig. 9); vein R_4 usually without appendix; cell R_4 relatively long; cell Cu_2 closed, petiolate. Genitalia without distinguishing features.

Male.—Head wider than thorax. Eyes bare, holoptic, enlarged facets in upper two-thirds sharply defined, not separated from occipital margin by line of small facets. Ocellar tubercle raised above upper eye level. Face entirely pollinose, rather flat. Palpi short, subovoid. Antennæ short, basal segments beadlike, and style triannulate as in female, but a little more slender. Abdomen with or without a dark dorso-median figure. Genitalia not dissected. Definition based on *S. formosiensis* only, as it is uncertain whether the male provisionally allotted to *suifui* really belongs here. The latter has beadlike antennal scape and pedicel, but a quadriannulate style (Fig. 54), so this character may be variable, as it is in some Bouvieromyiini. The genitalia (Fig. 55) are normal.

We propose this subgenus with hesitation, but it seems desirable to recognize the unusual features of the two included species, and their anomalous position between Bouvieromyiini and typical *Silvius*. They are exceedingly primitive in all respects, except the reduction of the frontal callus and antennal style, and it is possible that Shiraki's description of the eyes will prove to be correct when fresh material can be examined.

SILVIUS (NEOSILVIUS) SUIFUI sp. nov.

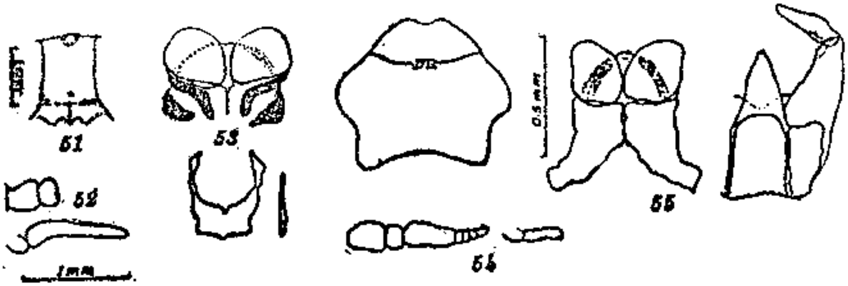
A small, yellow fly with yellow to orange appendages, and almost clear wings.

Holotype ♀, 8.5 mm. Frons golden-yellow pollinose, with sparse, short, yellow and black hairs, slightly divergent below (Fig. 51), index 1.3; ocelli on a raised, yellow pollinose tubercle; an obscure, small, shiny brown bare spot above, but not resting on, the yellow subcallus. Face and cheeks, yellow pollinose and sparsely pilose, with a few dark hairs toward the eyes. Antennæ (Fig. 52): scape and pedicel yellow, with yellow hairs, and a ring of strong, black bristles on the pedicel; flagellum orange, style with only three annuli (flagellum unfortunately lost before a drawing could be made). Palpi (Fig. 52) nearly as long as the stylets, with sparse yellow and a few black hairs on the second segment. Proboscis with yellow theca, fleshy brown labella.

Thorax heavily yellow pollinose, with an olive tint on the disc suggesting an underlying dark integument; scutellum concolorous; hairs sparse, yellow. Legs yellow, yellow-haired, but little darkened apically on tibiæ, with increasing numbers of black hairs distally; tarsi yellow to brownish, with yellow and black hairs. Wings (Plate 1, fig. 9) subhyaline with a gray tint; costal cell yellow; subepaulets orange, scalelike. Halteres orange.

Abdomen orange-yellow, without pattern; mostly with sparse black hairs, and with a few scattered yellow ones laterally and caudally. Genitalia (Fig. 53): divided tenth tergite rather slender; otherwise not distinctive.

CHINA, Suifu, Szechwan Province (*D. C. Graham*) no date; in USNM.



Silvius (Neosilvius) suifui **subgen. nov., sp. nov.**

FIG. 51, Frons of ♀; 52, basal antennal segments and palp of ♀; 53, genitalia of ♀; 54, 55, antenna, palp, and genitalia of presumed ♂.

A single male, from the same collector, cannot be associated definitely with the female, but the general resemblance between them is quite close. In view of the doubt, we refrain from designating it as allotype.

Male, 9 mm. Eyes bare. Ocellar tubercle yellow pollinose and pilose. Frontal triangle small, yellow pollinose. Face and cheeks, yellow pollinose and long, sparsely pilose, a few brown hairs along the ocular margins. Antennæ (Fig. 54): scape and pedicel dull yellowish, with long black hairs and a few yellow ones basally; flagellum deep orange, the four annuli of the style but little darkened. Palpal segments subequal in length, yellow, yellow-haired basally, the apical segment black-haired.

Thorax similar to female. Legs reddish, mostly black-haired; apical thirds of the fore tibiæ, hind knees, and tips of hind tibiæ and tarsi brown. Wings with costal cell yellow, veins basally yellow, apically brown. Halteres with yellow stalks, brown knobs.

Abdomen orange, with sparse, long, black hairs, the incisures not paler; dark figure on the first two tergites consisting of a transverse bar behind the scutellum, and an ovoid spot not quite reaching the hind margin of the second tergite. Venter similar, but without the basal median figure. Genitalia (Fig. 55) with style more slender than is usual in *Silvius*.

CHINA, Yao-Gi, alt. 4,000 to 8,000 feet, July, 1929 (*D. C. Graham*); in USNM. Province possibly Szechwan in view of preceding by same collector.

SILVIUS (NEOSILVIUS) FORMOSIENSIS Ricardo.

Silvius formosiensis RICARDO, Ann. Mus. Nat. Hung. 11 (1913) 173, ♀ ♂; KRÖBER, Arch. Naturges. 88 (1922) 131 (redescribed both sexes).

Ricardo (l.c.) described a syntype male and female each. Because of unfortunate, recent destruction of the Hungarian Museum collections, including the female, the syntype male in BMNH seen by us and labelled "Formosa, Toyenmongai, Pres. by Dr. Kertesz, 1912" is here designated as lectotype. It lacks one antennal flagellum, one mid and hind leg and one wing, but is in otherwise good condition. Except for sexual differences, it agrees closely with one female below, including entirely pollinose face and abdomen without pattern. Antennæ are darker orange, the style clearly triannulate, palpi very short, no spur veins. Upper large facets occupy about two-thirds the eye area.

Through the courtesy of Dr. F. Y. Cheng, we have also studied two females from Taiwan, determined by Dr. T. Shiraki subsequent to his 1918 Monograph. The frons is slightly divergent below, as in *suifui*, but there is no evidence of a bare spot, and Miss Ricardo wrote of a "hardly distinguishable" one on the type. Face entirely pollinose. Scape little longer than pedicel, both entirely yellow-haired; plate wide, ovoid, one and a half times as long as wide, length of the three annuli subequal to width of plate, terminal annulus but little shorter than the other two together. The tibiæ are more deep brown than black. Otherwise, they agree with Shiraki's description.

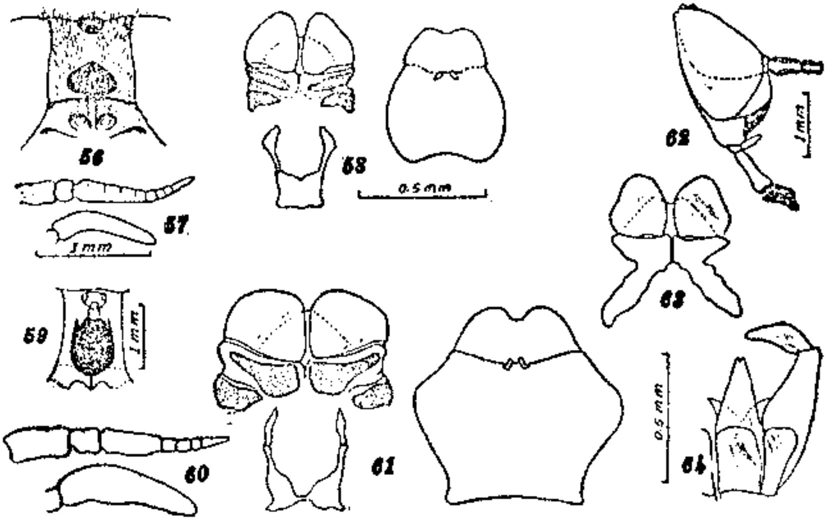
Genus SILVIUS Meigen

The six species included here agree with the genotype, *S. vituli* (Fabr.) of southern Europe, in all essential subgeneric characters, although they vary considerably in the degree to which a dark thoracic or abdominal pattern is developed.

SILVIUS (SILVIUS) ORNATUS sp. nov.

A striking, yellowish species, with ovoid callus, entirely pollinose face, vittate scutum, and banded abdomen.

Holotype ♀, 8 mm. Eyes bare, with the usual, irregular pattern of freckles (relaxed). Frons buff pollinose, with short black hairs, slightly divergent below and a little wider than tall (index 0.9); ocellar tubercle prominent, pollinose; callus (Fig. 56) dark brown, small, widely separated from the eyes, transversely ovoid, with a slight dorsal angle. Subcallus small, buff pollinose, with brown shadings above insertions of antennæ. Face and cheeks creamy yellow pollinose; beard sparse, straw yellow. Antennæ slender, shorter than head height; two basal segments yellow-brown; plate brown at base, darker distally, style black; proportions as in Fig. 57. Palpi slender, reddish, with pale yellow-brown vestiture. Labella black, fleshy.



***Silvius*, subgenus *Silvius* Meig.**

FIG. 56–58. *S. ornatus* sp. nov., ♀, frons, antenna and palp, genitalia: 59–61, same of *dorsalis* Coq., ♀: 62–64, *ceylonicus* Szil., ♂, head (broken line is division between large and small facets), genitalia.

Thorax buff pollinose, becoming gray behind, including scutellum; with two short, brown stripes sublaterally above wing bases, and a short, tapering, brown dash in front of scutellum. Pleural and coxal vestiture entirely yellow. Legs yellow, knees, distal parts of tibiæ and most of tarsi blackish; hairs mostly yellow, black distally on tibiæ and hind tibial fringes. Wings clear, costal cell tinted, veins yellow; no spur vein, but base of R_4 angulate. Halteres reddish yellow.

Abdomen pale yellow, with some pinkish tints on the basal two tergites; basal brown bands on each tergite, divided medially on the first three, and narrowest on the last two. Venter pinkish yellow, with an indefinite darker shadow in the middle of the first two sternites. Vestiture yellow, with black hairs over the dorsal bands. Genitalia (Fig. 58): eighth sternite relatively long and narrow, but struts at base of gonopophyses short, and other parts normal for the subgenus.

UPPER: BURMA, Nam Tamai Valley (27°42′N, 97°54′E), alt. 3,000 feet, August 15, 1938 (*R. Kaulback*); in BMNH.

Paratypes.—11 ♀, same data, in BMNH, Philippine Bureau of Science, Queensland Institute of Medical Research, and collection of C. B. Philip. Length 8 to 10 mm; occasional specimens are greasy, darkening the general color; there is some variation in frontal measurements, with a little more divergence below; the scapes are darker and more swollen inwardly in one specimen; and in another the bands on the first two tergites tend to coalesce in the middle.

S. ornatus is remarkably like *S. singularis* (Meigen), of which we saw the type female (labelled "Lucerne," but with "Allemagne" on the box label) and three other females from Rabat and Tangier in the Paris Museum. *S. singularis* differs chiefly in having a narrower frons (index 1.3); the callus rounded, and with short dorsal extension; face pollinose, but apodemal pits deep and bare; the three dark scutal vittæ longer and more prominent; and legs very dark only at the knees; abdominal patterns are similar. Another species which resembles *ornatus*, at least superficially, is *Chrysops croceus* Séguy, of which we also saw the type in Paris. It belongs to a small, Malagasian group of anomalous species with banded eyes and unpatterned wings [Oldroyd (1957) 63–67], and it differs from *ornatus* in having black parafacial calli, shining yellow face, swollen antennal scape, more reduced, *Chrysops*-like subcallus, legs blackish only on tarsi, and different abdominal pattern. More material would be needed to determine whether these resemblances between widely separated species have any phylogenetic significance.

SILVIUS (SILVIUS) INDIANUS Ricardo.

Silvius indianus RICARDO, Rec. Ind. Mus. 4 (1911) 374, ♀.

We have not seen this species, which was described from a single female in the Indian Museum collected in the Naini Tal district in northern India near the Nepalese border. It should be distinguishable from females of *dorsalis* and *matsumurai* by its smaller size (9 mm), darker general color, blackish figure at base of abdomen, and blackish tarsi. Face is "shining reddish yellow with a grayish-yellow rather tomentose median stripe" (Ricardo).

SILVIUS (SILVIUS) SHIRAKII nom. nov.

Silvius nigripennis SHIRAKI, Trans. Nat. Hist. Soc. Formosa 22 (1932) 259, ♂. Preoccupied by *Silvius nigripennis* Ricardo (1917) Australia (since transferred to *Mesomyia*).

It was at first thought that this might be the male of *formosiensis*, but study of the syntype male of the latter in the British Museum has shown that they are not the same, and, in fact, belong in different subgenera. The facial calli, quadriannulate style (Shiraki figures more than he describes), abdominal pattern, and tinted wings readily differentiate *S. shirakii*. The female, when discovered, may resemble *S. ornatus*, with at least the caudal tergites with transverse banding, but the wings should be tinted and the thorax darker.

SILVIUS (SILVIUS) CEYLONICUS Szilàdy.

Silvius ceylonicus SZILÀDY, Biol. Hung. (7) 1 (1926) 5, ♂.

The type male, kindly lent to us by Professor Max Beier, has two labels, the upper reading "Ceylon, alte Sammlung," and the lower "Schiner, 1869." Dr. Beier has informed us that the "alte Sammlung" localities have generally proved to be reliable. Nevertheless, this one is so far outside the previously known distribution of the genus that it should be accepted with reserve until more specimens are discovered.

The flagellar segments of the antennæ, most of the tibiæ, and all tarsi, are missing, but the type is otherwise in good condition, and its coloration seems to be well preserved. It is undoubtedly a *Silvius*, both on external and genitalic characters, and belongs to the subgenus *Silvius* as defined here. So far as can be judged from different sexes, it seems to be closer to *dorsalis* than to *indianus* except in facial characters.

Male.—Smaller than stated by Szilàdy, length 9 mm. Upper facets of eyes markedly enlarged, reddish, sharply marked off from the small, blackish, lower and posterior facets; ocellar tubercle prominent; frontal triangle and subcallus small, yellow pollinose; face and parafacials shining yellow, except for three yellow pollinose zones, a narrow median one above proboscis and a triangular area on each side on lower cheek; apodemal pits small, inconspicuous. Antennæ (Fig. 62): scape distinctly shining, yellowish at base, merging into deep brown to blackish distally, with rather short, similarly colored hairs; pedicel deep brown, less shining, with short, dark brown hairs. Palpi (Fig. 62) yellow, with long yellow hairs. Proboscis with yellow theca and dark brown, fleshy labella.

Thorax yellow, somewhat brownish on scutum, with light yellow hairs. Legs yellow, with yellow hairs, and some darker ones on remains of tibiæ. Wings pale brownish, with brown costal cell, stigma, and veins, and some brownish suffusion in first basal cell; vein sc bare above and below; R_4 rectangular at base, with short appendix; and anal cell closed almost at wing margin.

Abdomen yellow, with yellow to light brownish hairs; sides of basal and most of apical tergites more brownish, giving the impression of a pale, rather irregular median vitta on first five tergites, more distinct to the naked eye than at magnifications above × 10. Genitalia (Figs. 63, 64) typical of the genus, scarcely to be distinguished from those of *S. vituli.*

CEYLON, in the Vienna Museum.

SILVIUS (SILVIUS) DORSALIS Coquillett.

Silvius dorsalis COQUILLETT, Proc. U. S. Nat. Mus. **21** (1898) 309, ♀ (labelled "Japan, Mitsukuri").

Silvius coquilletti KRÖBER, Arch. Natg. Berl. (8) **88** (1922) 116, ♂ (Tokyo). Synonymy by Shiraki. (17)

Again through the courtesy of Dr. Cheng, we have seen one of the 1904 Hokkaido specimens described by Shiraki,(16) and have found it to agree closely with the type and two paratype females in the U. S. National Museum. The eyes show a few small purple spots (relaxed). The frons (Fig. 59) has an index 1.4. The antennæ (Fig. 60) are relatively long, with an unusually thick scape; palpi relatively stout; fore tibiæ noticeably thickened distally; and anal cell open in both wings; nevertheless, the insect is undoubtedly a *Silvius*, not a *Chrysops*. The genitalia (Fig. 61) are normal.

SILVIUS (SILVIUS) MATSUMURAI Kono and Takahasi.

Silvius matsumurai KONO and TAKAHASI, Ins. Matsum. **13** (1939) 151, ♀.

The type is from Hokkaido. Another female, from Mt. Daisetsu (also in Hokkaido), Matsumura, is in the material received from Dr. Cheng. On underside of label is written "Uchida Kono, 4–10 Aug. 1926." This specimen agrees in detail with the description of the type, and differs from *dorsalis*, as stated in the key, in smaller frontal and facial callosities, the latter above, not around, the apodemal pits.

Genus CHRYSOPS Meigen

CHRYSOPS SILVIARIS sp. nov.

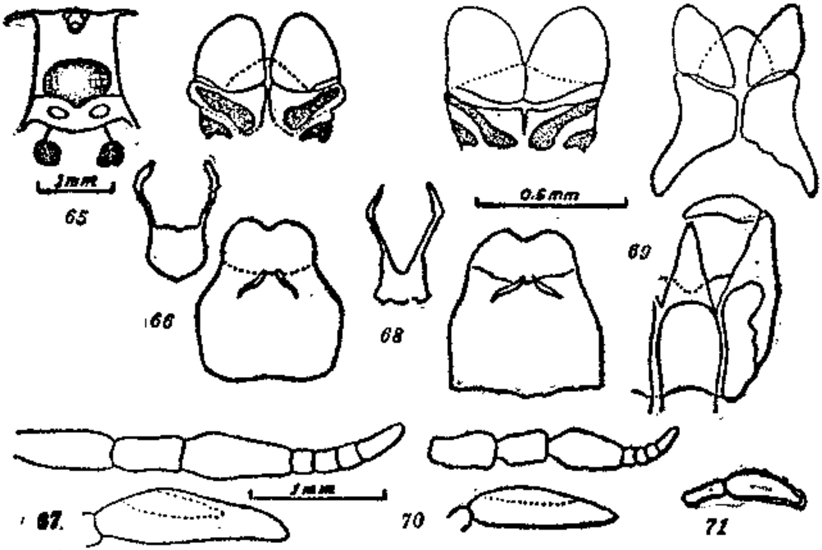
A rather large, yellowish-bodied species; with a peculiar, yellow pollinose, *Silvius*-like face, and a pair of shining, dark brown calli above the apodemal pits; the apical infuscation of the wing enclosing a hyaline patch in the radial area; and median, yellow-haired triangles on second and third abdominal tergites and narrow dark bands on incisures.

Holotype ♀, 12 mm. Eyes with indistinct, *Chrysops*-like pattern revived in the usual manner; frontal spot bilobed and deeply notched; upper and lower frontal spots barely separated from ocular margin; arrowhead isolated, large, and possibly without an upper shaft; occipital margin contiguous, but not revived enough for inner margin to be discerned. Frons (Fig. 65) yellow pollinose, a little taller than broad (index 1.2); ocellar tubercle darker; callus black, transverse-ovoid, not touching the eyes. Face more pollinose than other Oriental species, somewhat resembling *Silvius dorsalis*, but with two small but prominent blackish calli just above the apodemal pits; cheeks buff gray, with straw yellow beard. Antennæ (Fig. 67) a little longer than the head height; brown, scape yellow-brown below, distal segments darker, style blackish; scape and pedicel with black bristles; the segments stout but not swollen, the ratio of their lengths as 1.25:1.0:6.25. Palpi stout, orange-yellow, with yellow hairs.

Thorax, including scutellum, heavily yellow pollinose and pilose, with underlying darker integument on dorsum. Femora orange, with yellow hairs; knees and coxæ blackish; the tibiæ unswollen, brown, with black hairs and a distinct hind tibial fringe; tarsi darker. Wing (Plate 1, fig. 10) with basal cells diagonally infuscated in the basal half to third; crossband slightly wider than discal cell, complete to the hind margin, where it fills apices of cells Cu_2 and 1A; the apical infuscation enclosing a subhyaline, ovoid spot in cells R_1 and R_3, fading in R_5. Subepaulets and knobs of halteres blackish.

Abdomen yellowish, brownish behind fourth tergite; first and second tergites with large, black-haired, sublateral patches; third and fourth tergites brown, with median transverse yellow bands, and narrow darker bands on incisures 2 to 3 and 3 to 4, but broken medially on the former by a median yellow quadrate spot on second tergite. Venter pale yellow pollinose and pilose, a little darker behind third sternite. Genitalia (Fig. 66) normal, with the usual long struts at base of gonopophyses; spermathecæ unusually short and wide.

BURMA, S. Shan States, nr. Loimwe, Pangwai, alt. 5,000 feet, 1937, (per *F. J. Meggitt*); in BMNH.



Chrysops Meig.

FIGS. 65-67, *C. silviaris* sp. nov., ♀: frons, genitalia, antenna and palp; 68-71, *fascipennis* (Kröb.). ♀ genitalia, ♂ genitalia, antenna and palp of ♀, palp of ♂.

The pollinose face and distinctive wing and abdominal patterns relate this to no other Oriental species that we have seen.

CHRYSOPS FASCIPENNIS (Kröber), comb. nov.

Silvius fascipennis KRÖBER, Arch. Natg. Berl. (8) 88 (1922) 132, August (in error, *fasciatus*, p. 119); SHIRAKI (1932) as *C. fasciatipennis* (lapsus).

Silviochrysops flavescens SZILÀDY, Ann. Mus. Nat. Hung. 19 (1922) 126, December. Genotype of *Silviochrysops* Szilàdy (1922).

A male and two females from Taihoku and Karenko, Taiwan (Shiraki), furnished by Dr. Cheng are rather pallid, with reduced scutal and abdominal patterns, and relatively short antennæ, but they are typical *Chrysops* in all other respects. The eye pattern of the female is reduced to three rounded to ovoid spots isolated from the eye margins. The largest is the equivalent of the frontal spot, one behind it in the middle represents the reduced arrowhead, and the smallest is the lower frontal spot of the usual eye pattern. Somewhat similar reduction has occurred in the Nearctic species, *C. hirsuticalla* Philip and *C. divisa* Walker [Philip. (12)]. The area of enlarged facets in the male is sharply demarcated in nearly the upper three-fourths, without an occipital margin of small facets. The proportions of the antennal segments (Fig. 70) are almost exactly as in *C. hirsuticalla* [Mackerras (1955), fig. 20]. The shape of frons, swollen face, arrangement of the calli, palpi of both sexes (Figs. 70, 71), wing pattern (Plate 1, Fig. 11), and long eighth sternite of the female, with long, thin struts at the base of the gonopophyses (Fig. 68), are all characteristic of *Chrysops* rather than *Silvius*, and the shape of the ninth tergite and hypopygial style of the male (Fig. 69) would also support this assignment.

Silviochrysops Szilàdy is therefore added to the synonymy of *Chrysops* Meigen, *C. flavescens* falling among the species with undilated antennal and leg segments.

CHRYSOPS GRANDIS (Szilàdy).

Neochrysops grandis SZILÀDY, Ann. Mus. Nat. Hung. 19 (1922) 127. Genotype of *Neochrysops* Szilàdy, 1922, *nec* Walton, 1918; replaced by *Psylochrysops* SZILÀDY, Zool. Anz. 66 (1926) 328.

Two females from Taiwan were furnished by Dr. Cheng, the Arisan specimen listed by Shiraki,(17) and a later one collected near Hori in 1939. No eye pattern was revivable in either. They show remarkable resemblance to *C. longicornis* Macq. of tropical Africa, which Enderlein(3) made the type of his genus *Kleineana*. The peculiar antennal proportions (scape: pedicel: flagellum = 1.4:1.0:1.05 in *longicornis* and 1.5:1.0:1.0 in *grandis*), plus swollen snout and tibiæ, certainly appear to make them congeneric in a restricted sense. However, Enderlein differentiated *Kleineana* primarily on the basis of narrowly dichoptic eyes in the male, and males of *grandis* are not available, so a strict comparison cannot be made. Several other species of *Chrysops* have males with separated eyes, and other characters intergrade, so we would regard both *Kleineana* and *Psylochrysops* as synonyms of *Chrysops*, until evidence to restore them is produced. Bequaert(1) has considered these to form "a fairly natural group, perhaps of subgeneric rank," with

Kleineana having priority. As Oldroyd(10) has pointed out, attempts to reclassify this complex genus should begin in the Holarctic areas where it is dominant.

SUMMARY

Thaumastomyia gen. nov., *haitiensis* (Stone), ♀, N. China, Korea; *Gressittia birumis* gen. nov., sp. nov., ♀, Hupeh, China; *G. nepalensis* sp. nov., ♂, Nepal; *G. apicalis* sp. nov., ♀, India; *G. media* sp. nov., Malaya; *G. flava* sp. nov., ♂, ♀, Sumatra; *Rhinomyza oculata* sp. nov., ♂, N. Borneo, possible ♀, Java; *Silvius (Neosilvius) suifui* subgen. nov., sp. nov., ♀ and possible ♂, Szechwan, China; *S. (Silvius) ornatus* sp. nov., ♀, N. Burma; and *Chrysops silviaris* sp. nov., ♀, Burma, are described. *S. shirakii* nom. nov. is proposed for *S. nigripennis* Shiraki (not Ricardo). The new genus *Thaumastomyia* is monotypic; the type of *Gressittia* is *Gastroxides fuscus* Schuurmans Stekhoven; and of subgenus *Neosilvius* is *Silvius formosiensis* Ricardo. Also transferred to *Grassittia* is *Gastroxides aterrimus* Schuurmans Stekhoven. *Silviomyza,* gen. nov., provisionally included in tribe Chrysopini, is proposed for *Silvius piceus* Szilàdy, Ceylon. *Silviochrysops* and *Psylochrysops* Szilàdy, and *Kleineana* Enderlein are considered to be synonyms of *Chrysops.* Keys are given to Asiatic genera and subgenera, and to speices of *Gressittia, Rhinomyza,* and *Silvius.* A significant relationship between elements in the Ethiopian and Far Eastern tabanid faunas is apparent in this study, as well as the unreliability of hind tibial spurs alone as a subfamily character.

ADDENDUM

After this report was in proof, CBP found what is probably the unique but unlabelled type ♀ of *Gressittia aterrimus* (Schuurmans Stekhoven) reported in our earlier discussion as missing in the Raffles Museum Collection now at BMNH. The specimen, with printed label carrying the correct data and date from Negri Sembilan, Malaya, was discovered in a drawer of miscellaneous specimens from the Buitenzorg Museum in Java, received at Natura Artis Magistra, Amsterdam. This material was undoubtedly studied by the describer in Java, and he mentions only one specimen.

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ILLUSTRATIONS

PLATE 1

[Photographs by M. Josephine Mackerras, except Fig. 5.]

FIG. 1. *Gressittia birumis* gen. nov., sp. nov. ♀.
2. *G. fusca* (Sch. Stk.), ♀.
3. *G. aterrima* (Sch. Stk.), ♂.
4. *G. media* sp. nov., ♂.
5. *G. nepalensis* sp. nov., ♂.
6. *G. apicalis* sp. nov., ♀.
7. *Eucompsa aureocincta* End., ♀.
8. *Rhinomyza fusca* Wied., ♂.
9. *Silvius* (*Neosilvius*) *suifui* subgen. nov., sp. nov., presumed ♂.
10. *Chrysops silviaris* sp. nov., ♀
11. *C. fascipennis* (Kröb.), ♂.

TEXT FIGURES

FIG. 1. Distribution of Rhinomyzini. To the west, African-Malagasian genera; center above, *Gastroxides;* to the east below, *Rhinomyza.*
2. Distribution of Bouvieromyiini. Solid spots, *Gressittia;* circles, *Thaumastomyia* in the north; triangles, African-Malagasian genera to the west, *Eucompsa* in Java and Borneo, Australasian genera to the east.
3. Distribution of *Silvius.* Solid spots, subgenus *Silvius;* circles, subgenus *Neosilvius.*

[*Thaumastomyia* gen. nov., ***haitiensis*** (Stone), ♀.]

FIG. 4. Profile of head.
5. Frons.
6. Antenna (from a cleared preparation).
7. Palp.
8. Terminal segments and cerci.
9. Eighth sternite and gonopophyses.
10. Furca and caudal end of spermathecal duct.
11. Wing.
12. *Gressittia nepalensis* sp. nov., ♂. Antenna and palp.

[*Mesomyia* (*Pronopes*) *flavipes* Hine, ♀.]

FIG. 13. Profile of head.
14. Frons.
15. Antenna.
16. Palp.

[*Gressittia* gen. nov., heads, frons, antennæ, palpi, ♀ and ♂ genitalia.]

FIG. 17, 18, 22, 28–30. *G. fusca* (Sch. Stk.), ♀; 33, 34 ♂ genitalia of same; 19, 23, *flava* sp. nov., ♀; 20, 21, 24, 31, 32, ***birumis*** sp.

nov., ♀; 25, *apicalis* sp. nov., ♀; 26, *media* sp. nov., ♂ (broken line is the division between large and small facets); 27, *aterrima* (Sch. Stk.), ♂.

[*Eucompsa aureocincta* End., ♀.]

FIG. 35. Profile of head.
36. Frons.
37. Antenna and palp.
38. Genitalia.

[*Rhinomyza* Wied.]

FIG. 39–41. *R. fusca* Wied., ♀, head, frons, genitalia (furca with posterior end to right.)
FIG. 42, 43, ♂ of same, genitalia, antenna.
44. *R. oculata* sp. nov., ♂, antenna.
45, 46. Presumed ♀ of *oculata*, antenna and palp.

[*Silviomyza* (gen. nov.) *picea* (Szil.), ♀.]

FIG. 47. Profile of head.
48. Frons.
49. Antenna and palp.
50. Genitalia.

[*Silvius* (*Neosilvius*) *suifui* subgen. nov., sp. nov.]

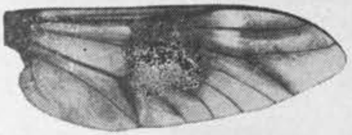
FIG. 51. Frons of ♀.
52. Basal antennal segments and palp of ♀.
53. Genitalia of ♀.
54, 55. Antenna, palp, and genitalia of presumed ♂.

[*Silvius* subgenus *Silvius* Meig.]

FIG. 56–58. *S. ornatus* sp. nov., ♀, frons, antenna and palp, genitalia.
59–61. Same of *dorsalis* Coq., ♀.
62–64. *S. ceylonicus* Szil., ♂, head (broken line is the division between large and small facets), genitalia.

[*Chrysops* Meig.]

FIG. 65–67. *C. silviaris* sp. nov., ♀, frons, genitalia, antenna and palp;
68–71. *C. fascipennis* (Kröb.), ♀ genitalia, ♂ genitalia, antenna and palp of ♀, palp of ♂



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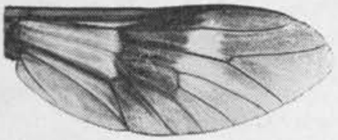

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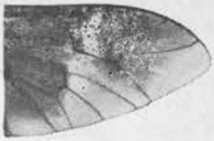

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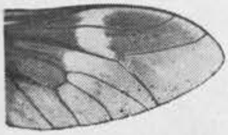

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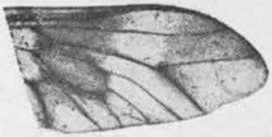

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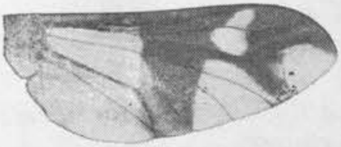

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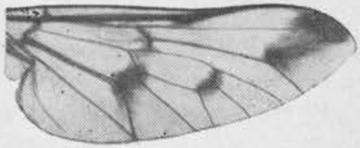

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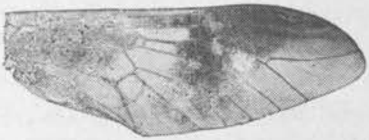

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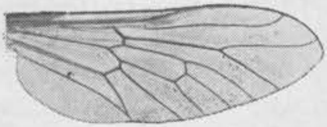

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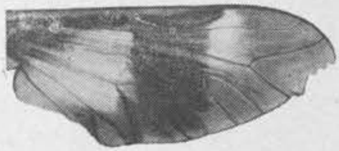

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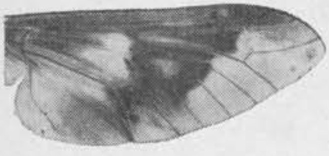


11

THE PHILIPPINE SPECIES OF PARABOLOGRATUS (CICADELLIDÆ, HOMOPTERA)

By SANTIAGO R. CAPCO
Bureau of Plant Industry, Manila

TWENTY-FOUR TEXT FIGURES

Leafhoppers belonging to this group are generally grass-green, some with orange-red faciæ. The nymphs are also green. They are abundant during the rainy season and scarce at other times when grasses begin to dry out. Their presence can hardly be detected among the host plants unless one makes a fast sweep with an insect net.

The very common species (*porrectus*) is often found on the lowland among grasses near banks of rivers, brooks, ponds, and long dikes of rice paddies. One rare species (*antipolanus*) was collected by sweeping among buho, *Schizostachyum lumampao* Blanco (Merrill) in Antipolo, Rizal.

In the present paper, five species are reported, two of them new, and another two representing the first record in this country. The species *rusticus* and *merinoi* are very similar in size, color, and superficial appearance and it is very hard to separate them without examining the female seventh sternum and male internal genitalia.

Distant(2) described five species from India and Ceylon under the genus *Thomsoniella* Signoret and the type was *T. porrectus* Walker. The genus was placed under the division of the Hecalusaria, subfamily Jassinæ (including Acocephalinæ). In 1918, he finally recognized the genus *Parabolocratus* Fieber and made Signoret's *Thomsoniella* a synonym, and fixed *P. glaucescens* Fieber as the type. Merino(5) followed Distant's old concept and continued to use (*Thomsoniella* in recording two species, *porrectus* and *albomaculatus* for the Philippines. Upon careful checking of the males of *porrectus* in the Bureau of Plant Industry collection, they all agree very well with Distant's original description and illustration of *albomaculatus*. I can conclude therefore, that *albomaculatus* is the same as *porrectus* and that it showed a case of sexual dimorphism of the species.

Evans,(4) Oman,(6) and Beirne(1) correctly placed the genus *Parabolocratus* under the tribe Hecalini of the subfamily Hecalinæ.

The materials studied were from the Bureau of Plant Industry Collections, abbreviated as BPI Coll.

Genus **PARABOLOCRATUS** Fieber

Parabolocratus Fieber, Berh. z.-6. Ges Wien (1866) 502, Plate 7, fig. 13, Rev. Mag. Zool. 2 (1875) 404, Plate 12; Signoret, Ann. Soc. Ent. Fr. (1879) 5, 275; Oshan., Verz. Pal. Hem. Hom. 2 (1906) 86; Distant, Ins. Transvaal (1910) 239, Plate 23, fig. 7a, Faun. Frit Ind. Rhyn. 7 (1918) 30–32, fig. 13; Evans, Trans. Roy. Ent. Soc. Lond. (6) 98 (1947) 141; Oman, Mem. Ent. Soc. Wash. 3 (1946) 33; Ishihara, Sci. Rept. Mats. Agri. Coll. 11 (1953) 36; Beirne, Canadian Ent. (2) 58 (1956) 13.

Thomsonia Signoret, Ann. Soc. Ent. Fr. (1879) 51.

Thomsoniella Signoret, Ann. Soc. Ent. Fr. (1880) 52; Melichar, Hom. Faun. Ceyl. (1903) 171; Distant, Faun. Brit. Ind. Rhyn. 4 (1904) 277–278; Merino, Philip. Jour. Sci. 61 (1936) 354–355.

Type, *P. glacucescens* Fieber, a Palæartic species.

Body depressed; head as wide as pronotum, elliptically produced, vertex flat, anterior margin thin and subfoliaceous; frons with lateral sutures extending to anterior margin; lateral margins of genæ incised below eyes; clypeus swollen; clypellus short; pronotum broad and short, disk, basally, transversely rugulose, lateral margins carinate and diverging slightly posteriorly; scutellum with distinct arcuate depression near apex; forewings membranous, with distinct veins; female seventh sternum with posterior margin slightly produced medially and sometimes to distinct lobes; ædeagus large with dorsal extension near base and paired terminal processes.

Color green or yellowish-green and often with a fine fuscous tinge just below the anterior margin of head.

Distant(3) gave the distribution as Palæarctic, Nearctic, Oriental, Ethiopian, and Australian regions.

Key to the Philippine species of Parabolocratus

1. Body fasciated with orange-red 2
   Body not fasciated with orange-red 3
2. Vertex with 4 longitudinal fasciæ, pronotum, 6, scutellum 3, sometimes not clearly visible; males with apical area of forewings brown and with white spots; female seventh sternum with 3 medial lobes on apical margin, the middle lobe narrower and shorter than the other two; ædeagus with short dorsal extension near base and a pair of long perpendicular terminal processes bent anteriorly toward the tips, one directed dorsally and the other ventrally........ *porrectus* (Walker)

Vertex with 4 longitudinal fasciæ, pronotum, 4; narrow area along apical margin of vertex, lateral margins of pronotum and costal margin of forewings, whitish-yellow; forewing fasciated along veins; female seventh sternum with posterior margin very slightly produced medially; ædeagus with a long dorsal extension near base, a pair of terminal processes curved upward and scythelike at side view. *antipolanus* sp. nov.

Vertex with an arcute fascia, pronotum, 2; 3 longitudinal fasciæ on scutellum; forewings fasciated along veins, darker in males than in females; female seventh sternum with an angulated median lobe along apical margin, ædeagus with a long dorsal extension near base and 2 pairs of terminal processes, or petal-like .... *arcuatus* (Motschulsky)

3. Vertex, pronotum, scutellum green; narrow area along apical margin of vertex and 2 faint longitudinal lines on scutellum, light yellowish-green; female seventh sternum with a short arcuate median lobe along the apical margin; ædeagus with a longer dorsal extension almost perpendicular to the shaft, a pair of terminal processes directed upward or posteriorly .... *rusticus* Distant

Similar to *rusticus* in external appearance but female seventh sternum with 3 median lobes along apical margin, the one at center narrower and longer than the other two; ædeagus with a short dorsal extension near base, a pair of terminal processes long, curved, anteriorly and tips directed dorsally .... *merinoi* sp. nov.

PARABOLOCRATUS PORRECTUS (Walker).

Parabolocratus porrectus (Walker) DISTANT, Faun. Brit. Ind. Rhyn. 7 (1918) 31; WALKER (*Acocephalus*), List Hom. Suppl. (1858) 262; MELICHAR (*Thomsoniella*), Hom. Faun. Ceylon (1903) 173; DISTANT, Faun. Brit Ind. Rhyn. 4 (1904) 278–279, fig. 178; MERINO, Philip. Jour. Sci. 61 (1936) 355.

Thomsoniella albomaculatus DISTANT, Faun. Brit. Ind. Rhyn. 4 (1904) 280–281, fig. 179; DISTANT (*Parabolocratus*), Faun. Brit. Ind. Rhyn. 7 (1918) 32; MERINO, Philip. Jour. Sci. 61 (1936) 355–356.

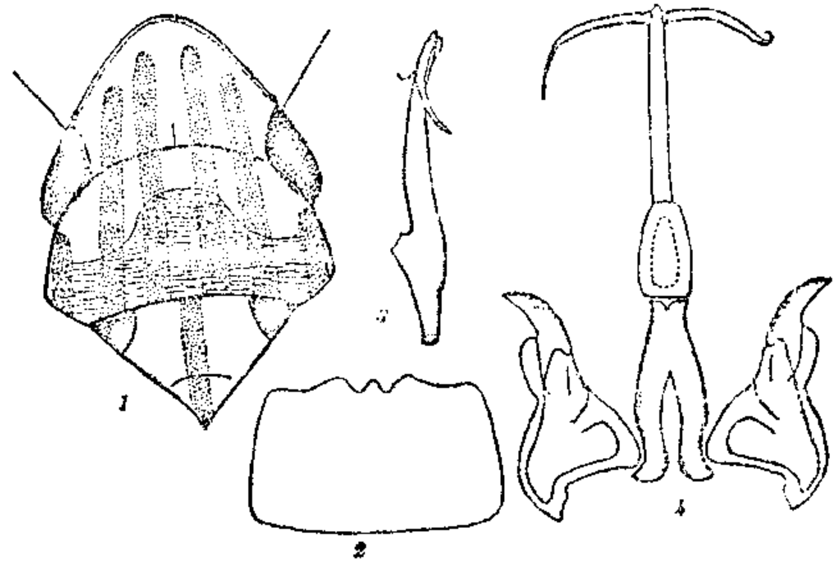
Platymetopius lineolatus MOSTSCHULSKY, Etud. Ent. 8 (1850) 114; KIRKALDY (*Thomsonia*), Rep. Expt. Sta. Hawaiian Plant. Assoc. 9 (1906) 337.

Hecalus kirschboumii STÅL, Ofv. Vet-ak. Forh. (1870) 737; SIGNORET, (*Thomsoniella*), Ann. Soc. Ent. Fr. 52 (1880) Plate 1, fig. 44; ATKINS., J. A. S. B. 54 (1885) 104; KIRKALDY (*Thomsonia*), Rep. Expt. Sta. Hawaiian Plant. Assoc. 9 (1906) 338.

Length: female, 6.0 to 6.2 millimeters to tip of forewings and 6.5 to tip of abdomen; male, 5 to 5.2 millimeters to tips of forewings.

Green; female with longitudinal orange-red fasciæ, sometimes not clearly visible, vertex, 4, pronotum, 3 and scutellum, 3; eyes, apical margin of vertex and fine lines along it, fuscous; face, abdomen, and legs yellowish-green; male not fasciated, abdomen above black with lateral margins light yellowish-brown; apical area of forewings brown, with white spots.

Vertex shorter than pronotum, width less than twice length, flat, sub-angularly produced, anterior margin reflexed; pronotum nearly twice wider than long; basal half finely, transversely rugulose; female abdomen longer than forewings, but male shorter.



Parabolocratus porrectus (Walker)

FIG. 1. Head, pronotum and scutellum, dorsal view; 2, female seventh sternum, ventral view; 3, ædeagus, side view; 4, male internal genitalia, ventral view.

Female seventh sternum distinctive, with 3 median lobes on apical margin, middle lobe narrower, shorter and acutely produced than the other two.

Male internal genitalia with style, triangular, apex moderately curved outward and pointed; connective long, an inverted V-like; ædeagus with shorter dorsal extension near base, a pair of long perpendicular terminal processes bent anteriorly towards tips, one directed dorsally and the other ventrally.

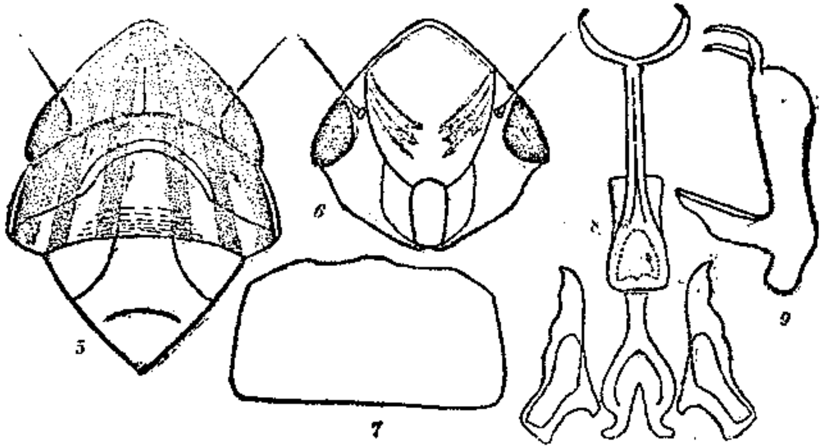
BPI Coll., LUZON: Manila (August 23, 1948, F. Q. Otanes; November 9, 1949, V. Madrid; January 9, 1954, S. R. Capco); Pateros, Rizal (December 27, 1953, January 17, 1954, June 16, 1957, S. R. Capco; August 31, September 3, 1957, A. Dagan); Makati, Rizal (January 11, 1954, F. Candelaria); Los Baños, Laguna (January 3, 1953, S. R. Capco); Lipa, Batangas (January 21, 1954, S. R. Capco); Sanches Mira, Cagayan (August 18, 1954, S. R. Capco).

Males are generally smaller and the vertex shorter than the females. This common species is sexually dimorphic; the male was described by Distant (1908) as *albomaculatus*. In collecting this species since 1937, I have always found the males different from the females.

PARABOLOCRATUS ANTIPOLANUS sp. nov.

Length: female, 8 millimeters to tips of forewings and 8.5 to tip of abdomen; male, 6.4 millimeters to tips of forewings.

Grass green with longitudinal fasciæ, vertex, 4, pronotum, 4, and oblique fasciæ of forewings, orange-red; narrow area along apical margin of vertex, later margins of pronotum and costal margins of forewings, light whitish-yellow; fine line along apical margin of vertex, eyes, and tarsal claws, fuscous; face, abdomen and legs, light green; tibiæ of fore and middle legs and tibial spines, yellow.



***Parabolocratus antipolanus* sp. nov.**

FIG. 5. Head, pronotum and scutellum, dorsal view; 6, head, ventral view; 7, female seventh sternum, ventral view; 8, male internal genitalia, ventral view; 9, ædeagus, side view.

Vertex, shorter than pronotum, width about twice length, more angularly produced than *porrectus*, subreflexed anteriorly, surface smooth; pronotum width more than twice length, smooth, finely, transversely rugulose near base, a narrow, arcuate shallow depressed area on disk, lateral margins carinate; scutellum large, about one-third wider than long, a curved, transverse, impressed line at about one-third from apex; female abdomen a little longer than forewings, the male shorter.

Female seventh sternum distinctive and with apical margin very slightly produced medially and wavy.

Male internal genitalia, with style, long, erect, slightly curved and pointed at apex; connective long and Y-shaped; ædeagus at dorsal view enlarged near base and slender towards apex, a pair of terminal processed curved posteriorly, and narrower near pointed tips, at side view, with a long perpendicular extension dorsally near base, wider posteriorly, terminal processes scythe-like.

Type, male BPI Coll., LUZON: Antipolo, Rizal (December 4, 1957, S. R. Capco).

Paratypes, 8 females, same data as type.

These were collected on *buho* near a creek along the fence of Rizal Provincial Nursery in Antipolo, Rizal.

PARABOLOCRATUS ARCUATUS (Motschulsky).

Parabolocratus arcuatus MOTSCHULSKY (*Acocephalus*), Etud. Ent. **8** (1859) 15, Bull. Soc. Nat. Mosc. (3) **36** (1863) 100; MELICHAR (*Thomsoniella*), Hom. Faun. Ceyl. (1903) 172; DISTANT, Faun. Brit. Ind. Rhyn. **4** (1904) 280; DISTANT (*Parabolocratus*), Faun. Brit. Ind. Rhyn. **7** (1918) 32; KIRKALDY (*Thomosonia*), Rep. Expt. Sta. Hawaiian Plant. Assoc. **9** (1906) 337.

Tetigonia kalidasa KIRKALDY, Entomologist **33** (1900) 294.

Length: female, 5.0 to 5.2 millimeters to tips of forewings, 5.5 millimeters to tip of abdomen; male, 4.7 to 5 millimeters to tips of forewings.

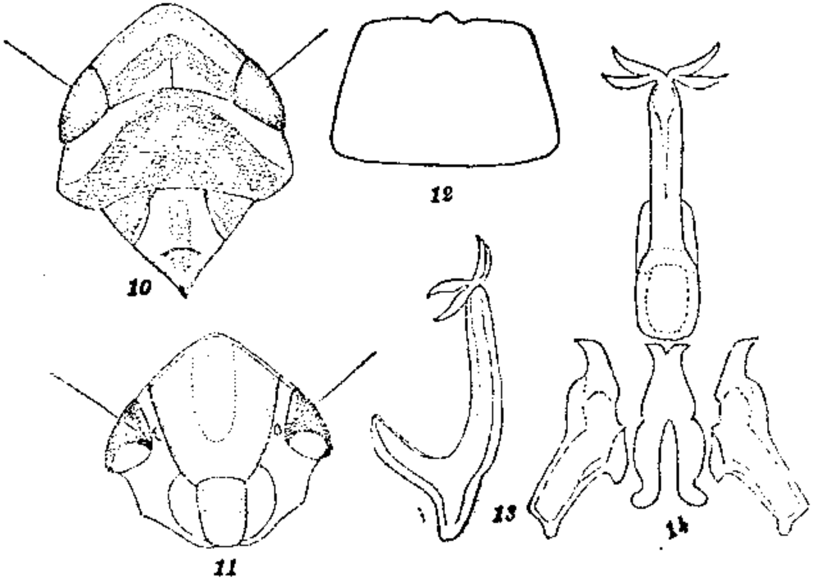
Pale green or greenish ochraceous; an arcuate fascia on vertex, two on pronotum, and three longitudinal fasciæ on scutellum (the two on the sides are extensions of the posterior fascia of pronotum) and longitudinal, oblique fasciæ on forewings, orange-red (fasciæ darker in males than in females); eyes, apical margin of vertex, two apical spots of forewing after clavus, fine line near apical margin of frons, fuscous; female, face, abdomen and legs, greenish-yellow; apex of abdomen, ochraceous; male, face, abdomen below, lateral margins of abdomen above, and legs, yellow; abdomen above black; apical area of forewings, light brown with few pale white spots.

Vertex shorter than pronotum, width about twice length, angularly produced, slightly reflexed; pronotum width more than twice length; finely transversely rugulose at posterior two-thirds; scutellum triangular, width one and a half times length;

a curved, transverse, impressed line at one-third from apex; face similar to that of *porrectus* in outline.

Abdomen of female almost as long or a little longer than forewings; male abdomen shorter.

Female seventh sternum distinctive and with a low median lobe, angulately rounded at tip along the apical margin.



Parabolocratus arcuatus (Motschulsky)

FIG. 10. Dorsal view of head, pronotum and scutellum; 11, head, ventral view; 12, female seventh sternum, ventral view; 13, ædeagus, side view; 14, male internal genitalia, ventral view.

Male internal genitalia, style with base extended ecto-anteriorly; apex slightly curved towards pointed tip; connective long and inverted V-shaped; ædeagus stout, with long dorsal extension near base, and two pairs of terminal processes, blade, or petal-like.

BPI Coll., LUZON: Mckinley (Makati), Rizal (July 14, 1957, A. Dagan); Pateros, Rizal (August 8, September 3, 1957, A. Dagan; August 27, 1957, S. R. Capco); Antipolo, Rizal (November 19, 1957, September 11, November 19, 1958, S. R. Capco).

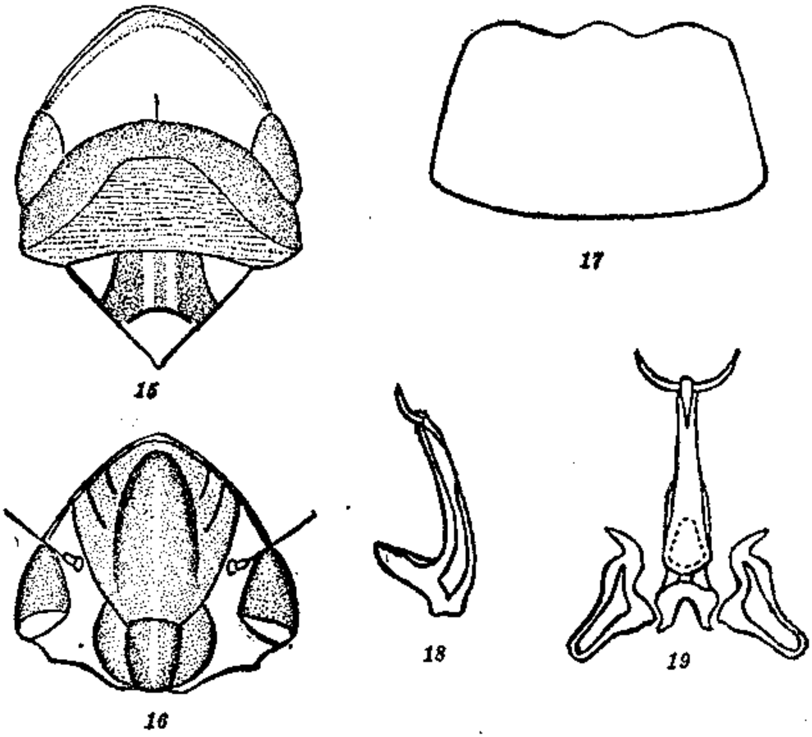
The species were collected among grasses along river banks and side roads. It is reported for the first time in the Philippines.

PARABOLOCRATUS RUSTICUS Distant.

Parabolocratus rusticus DISTANT, Faun. Brit. Rhyn. 7 (1918) 31.
Thomsoniella viridis DISTANT (preoccupied), Faun. Brit. Ind. Rhyn. 4 (1904) 280.

Length: female, 6.0 to 6.5 millimeters to tips of forewings, 7.0 millimeters to tip of abdomen; male, 5 millimeters to tips of forewings.

Very similar to *porrectus* but differs in the absence of orange-red fasciæ; the two faint longitudinal lines on scutellum and narrow area along apical margin of vertex, yellow-green.



***Parabolocratus rusticus* Distant**

FIG. 15. Ventral view of head, pronotum and scutellum; 16, ventral view of head; 17, female seventh sternum; 18, ventral view of male internal genitalia; 18, lateral view of ædeagus.

Female seventh sternum distinctive and with a median lobe along apical margin, roundly produced abruptly.

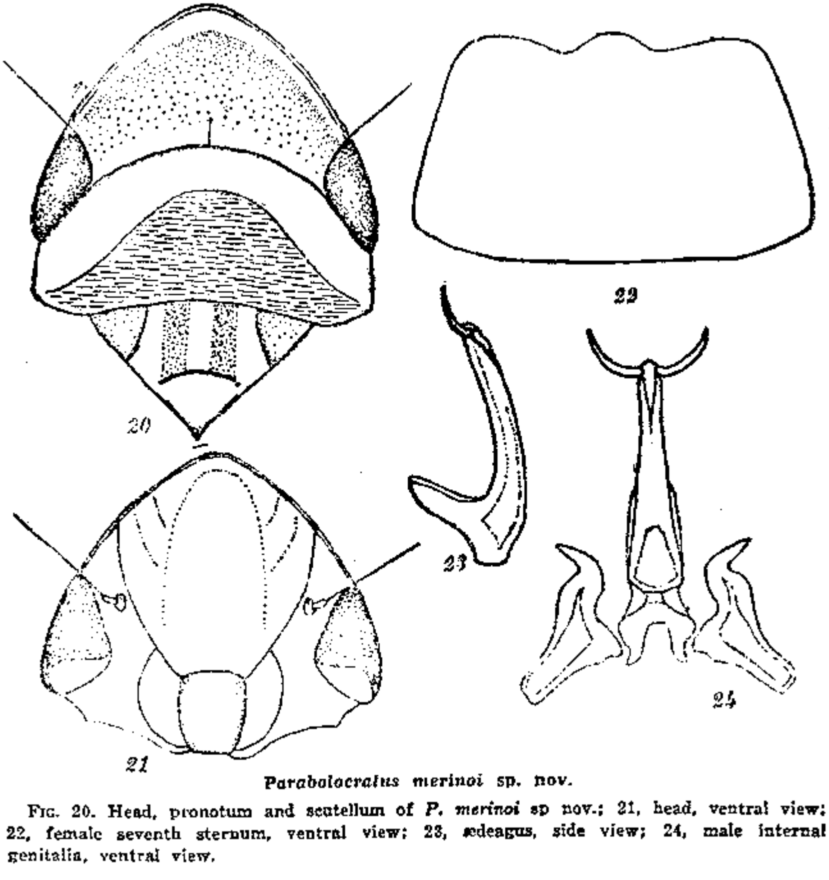
Male internal genitalia with style small, curved, S-like posteriorly and tip narrowly pointed; connective short and inverted V-like; ædeagus with a dorsal extension near base and moderately tapering towards apex, a pair of terminal processes moderately curved posteriorly.

BPI Coll. LUZON: Antipolo, Rizal (September 11, 1958, S. R. Capco); Camalaniugan and Ballesteros, Cagayan (August 12, 1957, S. R. Capco).

These leafhoppers were collected among grasses near corn fields and rice paddies. The species was originally described by Distant 1904 as *viridis*. He later(3) changed it to *rusticus*, because his *viridis* was preoccupied by Uhler's Nearctic species. The males have shorter vertex than the females. It is reported for the first time in the Philippines.

PARABOLOCRATUS MERINOI sp. nov.

Length: female, 6.0 to 6.5 millimeters to tip of forewings, 6.4 to 7.0 to tip of ovipositor; male 5.0 to 5.5 millimeters to tip of forewings.



Parabolocratus merinoi sp. nov.

FIG. 20. Head, pronotum and scutellum of *P. merinoi* sp nov.; 21, head, ventral view; 22, female seventh sternum, ventral view; 23, ædeagus, side view; 24, male internal genitalia, ventral view.

Females very similar to *rusticus* in color and external appearance but the yellow area along apical margin of vertex wider and the genofrontal sutures of face not evenly curved (see illustrations of head, ventral view). Males similar to *porrectus* in color and external appearance.

Female seventh sternum distinctive, three median lobes along the apical margin very similar to *porrectus* but the middle lobe longer than the other two.

Male internal genitalia with style large, wide at base, the apex more curved and sharply pointed; connective, inverted V- or nearly Y-shaped: ædeagus with a triangular base, dorsal extension small at side view, a pair of terminal processes long and curved anteriorly tips directed dorsally.

Type, male BPI Coll., LUZON: Trinidad, Mountain Province (March 4, 1954, S. R. Capco).

Paratypes, 5 females and 6 males, same data as type and Baguio, Mountain Province (March 5, 1954, S. R. Capco).

The types of this new species were collected on grasses along a canal with clear running water in the compound of Mountain National Agricultural School, Trinidad, Mountain Province.

I am naming this species in honor of Dr. G. Merino, retired entomologist and former director of the Philippine Bureau of Plant Industry, who did taxonomic work on Philippine Cicadellidæ.

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NOTES ON A COLLECTION OF AMPHIBIANS FROM MINDANAO ISLAND, PHILIPPINES

BY DIOSCORO S. RABOR and ANGEL C. ALCALA
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Our inadequate knowledge of the herpetofauna of most of the high-mountain localities of the Philippines has been pointed out.[1] Among the localities of the herpetofaunas which are not known at present are those of Mt. Malindang in northeastern Zamboanga and of Surigao Province, both of Mindanao Island.

This paper is based on the limited collections and observations made in the Mt. Malindang area in March, April, and May, 1956, by a collecting party headed by the senior writer and sponsored jointly by the Chicago Natural History Museum, Yale University Peabody Museum, and Silliman University, which was intended primarily to collect birds and mammals, and to study the ecology and biology of these animals.

The few specimens from Surigao Province were collected by Haniel Castro.

In view of the recent revision of the Philippine amphibia by Inger,[2] the systematic accounts in this paper have been minimized by presenting only such descriptive data as would supplement those of Inger.

MT. MALINDANG

Mt. Malindang rises about 7,965 feet above sea level, and is easily the most prominent feature in the northeastern part of Zamboanga Peninsula in western Mindanao. The mountain extends in a general north-south direction and is long but narrow. It has many peaks but the main peak towers prominently over the remaining parts of the low Cordillera that extends the length of the peninsula.

On the whole, the Mt. Malindang area for the greater part of its length and width, and for about half of its elevation, is still covered with dense original forests. On the southern and southeastern parts, from the base to about 4,000 to 4,500 feet up the slopes of the numerous peaks, much of the original forests has been cleared for cultivation. This particular zone of any high Philippine mountain is usually the most productive as far as collecting amphibians, reptiles, birds, and mammals is concerned. The western and northwestern sides, although very rugged, have also been cleared of most of their original forests up to about 2,500 to 2,700 feet on the slopes of the peaks, but the greater part is still well covered with dense original forests. These sides of Mt. Malindang looked more promising for the collecting of land vertebrates and so most of the collecting was made here, from altitude about 2,500 feet up to the summit of the highest peak which is about 7,450 feet.

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[1] Brown, Walter C., and Angel Alcala. Silliman Jour. 2 (1955) 93–102.

[2] Inger, Robert F. Fieldiana: Zool. 33 (1954) 183–531.

The following were the main collecting localities:

1. *Gumay (altitude 2,700 to 3,000 feet)*.—A tiny sitio of about five Subano houses that clustered on top of a well-cultivated hill, closest to the lowest limit of the remaining original forest on the western side. Virgin dipterocarp forest occurs from 2,700 feet up to about 3,500 feet up the slope. The forest is typically three-storied, with the first, forming a closed canopy. The forest floor is generally moist and well shaded. Extensive patches of dense second growths and clearings immediately adjoin the edges of the virgin forest, from about 2,700 feet and below.

2. *Masawan (altitude 3,500 to 4,500 feet)*.—The forest in this area is mainly transition dipterocarp-midmountain rain forest type, in which the three-storied character of the forest is no longer very pronounced, although there are still occasional tall trees of the first story of the typical dipterocarp forest type among the more dominant second-story trees. In this elevation (3,500 feet) the Manila-copal tree or almaciga (*Agathis alba*) begins to appear.

The terrain is very rough, with numerous draws, deep creeks, gullies and steep mountainsides, all covered with dense original forests. At the time, there were four abandoned clearings in this locality, that ranged from 4 to 5 hectares each in area which were already going back to forest.

3. *Gandawan (altitude 4,500 to 5,500 feet)*.—Gandawan itself is only a small cleared part of a valley; planted by some Subanons to sweet potato. All around it are high mountain peaks, except on one side where it helps form the bank of the deep Dapitan River gorge. The forests in the valley and on the lower parts of the mountain slopes are transition dipterocarp-midmountain rain forest type. Halfway up the slopes of the mountains and up to the ridges, which are about 6,000 feet and above in

elevation, the forests change to real midmountain type with the characteristic two-storied tree growths rich in epiphytes.

4. *Dapitan River headwaters (altitude 5,100 to 7,450 feet).*—The entire collecting locality up to about 6,200 feet elevation was covered largely with untouched midmountain forest, except in a few places where small clearings were begun and then abandoned. Here the large Dapitan River begins as a small shallow creek that one can step across.

From 6,200 feet up to the top of the peak, the ridge and the steep sides are all covered with mossy forest, with its abundant growth of moss and other epiphytes on the trunks and branches of the trees. On the ridge the trees are stunted, crooked, and mostly reclining. There is always a strong breeze blowing. The trail along the ridge often leads from one reclining tree-trunk to another.

The small creeks at the base of the ridge of the northern peak, elevation at about 5,100 to 5,400 feet, are rather rich in amphibians, as are also the moist forest floor. The highest elevation at which an amphibian was collected was at 6,500 feet on the ridge that led to the northern peak, which was about 7,450 feet altitude. Here frogs were taken either from trunks of trees or from the moist forest floor.

SURIGAO

Sibahay (altitude 500 to 1,000 feet): A barrio about 7 kilometers from the town of Lanuza. The area was already more or less cleared with remnant forests in the hills and mountains nearby. Collecting was made in April and May, in the small creeks among the hills.

LIST OF SPECIES

A total of fifteen species were identified. Specimens of *Rana parva* and *Rhacophorus surdus* were compared with closely related forms in the collection of the Chicago Natural History Museum.

The specimens in the present study are in the collection of the Chicago Natural History Museum, Stanford University Natural History Museum, and Silliman University.

MEGOPHRYS HASSELTI (Müller).

1 ♂ Gandawan, Mt. Malindang, Zamboanga Peninsula; altitude 4,500 to 5,500 feet.

The single specimen was taken from the forest floor which was typically moist and shady.

MEGOPHRYS MONTICOLA STEJNEGERI (Taylor).

1 ♂, 1 ♀, Masawan, Mt. Malindang, Zamboanga Peninsula; altitude 3,500 to 4,500 feet.
1 ♂, 1 juv., Gumay, Mt. Malindang, Zamboanga Peninsula; altitude 2,700 to 3,000 feet.
1 ♂, 2 ♀♀, 41 tadpoles, Gandawan, Mt. Malindang, Zamboanga Peninsula; altitude 4,500 to 5,500 feet.

The adult and the juvenile specimens were collected from the moist floor of original forest, elevation from 2,500 to 5,500 feet.

The tadpoles were caught in a slow-flowing creek, where they were found to feed on the floating microörganisms including algæ and organic matters. The hindlimb buds are first seen in specimens measuring about 28 mm in total length. Tadpoles measuring about 33 mm have short hindlimbs, with the digits and three divisions of the limb clearly differentiated.

PELOPHRYNE LIGHTI (Taylor).

5 ♀♀, Dapitan Peak, Zamboanga Peninsula; altitude 5,100 to 6,500 feet.
1 ♀, Gandawan, Mt. Malindang, Zamboanga; altitude 4,500 to 5,500 feet.
1 ♂, 3 ♀♀, Masawan, Zamboanga; altitude 3,500 to 4,500 feet.

This toad shared the same habitats with *Ansonia muelleri* in the places explored in the Malindang area.

The females differed from the single male in the ventral color pattern, which was dark with light spots; the male was whitish or light tan mottled with black. The females were longer (18 to 20 mm in snout-vent length) than the male (15.5 mm in snout-vent. length).

ANSONIA MUELLERI (Boulenger).

16 ♂♂, 15 ♀♀; 9 juvs. Dapitan Peak, Zamboanga; altitude 5,100 to 6,500 feet.
66 ♂♂, 5 ♀♀; 1 juv., Gandawan, Zamboanga; altitude 4,500 to 5,500 feet.
5 ♂♂, 4 ♀♀, 4 juvs., Masawan, Zamboanga; altitude 3,500 to 4,500 feet.

This toad was the most common amphibian encountered and collected in the Malindang area, altitudes between 3,500 and 6,500 feet. Individuals of this species were seen on the forest floor whether near or away from bodies of water.

The females of our sample ranged from 30 to 41 mm in snout-vent length.

OOEIDOZYGA LÆVIS LÆVIS (Günther).

1 ♀, Sibahay, Surigao; altitude 500 to 1,000 feet.

This single specimen was collected from a creek.

RANA SIGNATA GRANDOCULA Taylor.

5 ♂♂, Sibahay, Surigao; altitude 500 to 1,000 feet.

These specimens were collected from the creeks in the locality.

RANA PARVA Taylor.

1 ♀, Dapitan Peak; Zamboanga; altitude 5,100 to 6,500 feet.
1 ♀, Masawan, Zamboanga; altitude 3,500 to 4,500 feet.
1 ♀, 1 juv., Gandawan, Zamboanga; altitude 4,500 to 5,500 feet.

This frog was collected from the moist forest floor, near or away from the immediate vicinity of water.

Taylor[3] distinguishes between *Rana parva* Taylor and *micrixalus* Taylor in the following way:

- *micrixalus* has broad dorsolateral fold; *parva* has none;
- *micrixalus* has nostril equidistant between eye and tip of snout; in *parva*, closer to tip of snout;
- *micrixalus* with shagreened skin and pustules posteriorly; *parva* with skin on back smooth;
- *micrixalus* tibiotarsal joint reaching beyond tip of snout; in *parva* not quite so far;
- *micrixalus* with pectoral fold; without in *parva;*

Inger[4] recognizes two species but notes only two differences:

- *micrixalus* with pectoral fold; without in *parva;*
- *micrixalus* with shagreened skin or with pustules posteriorly; *parva* with smooth or shagreened skin.

In our four specimens we found the following:

- CNHM 50269–70 (Mt. Malindang, Mindanao; DSR 437, DSR 330) with smooth skin;
- DSR 390, DSR 479 (Mt. Malindang, Mindanao) with shagreened skin;
- DSR 390, DSR 479 (Mt. Malindang, Mindanao) with dorsolateral folds; others without;

all four specimens have pectoral folds;
position of nostril varies slightly and may be in either position noted by Taylor;
tibiotarsal articulation reaches beyond snout in CNHM 50270 (DSR 437), but not in CNHM 50269 (DSR 390).

There is the possibility that *micrixalus* is a synonym of *parva*. Variation in appearance of dorsolateral folds is common in some ranids (e.g. *R. signata, R. microdisca*) and can be affected by quality of preservation. Some variation in the texture of the skin results from the same cause. Finding the two types of skin in the series makes it most unlikely that the species are distinct. The agreement in the greatly reduced webbing, in the large eggs, in the expanded toe tips, and in the pectoral fold is too remarkable to ignore.

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[3] Taylor, Edward Harrison. Philip. Jour. Sci. 22 (1923) 526.

[4] Inger, R. F., *op. cit.*, 300–304.

The color in formalin was light-brown to grayish-brown above and grayish-white below. Of the four specimens, three possessed crossbars on the limbs. An inverted Y-shaped mark between the arms on the back was clear in the two lighter-colored individuals.

The biggest ovarian eggs were pigmented, black in the animal hemisphere and cream in the vegetal. They measured about 1.8 mm in diameter.

RANA MAGNA MAGNA Stejneger.

2 ♂♂, Sibahay Surigao; altitude up to 1,000 feet.

This species was abundant in the creeks of the locality. One of the specimens had a dark W-shaped mark on the back.

STAUROIS NATATOR (Günther).

4 ♂♂, 1 ♀, Sibahay, Surigao; altitude up to 1,000 feet.

These specimens were collected in the creeks.

CORNUFER MEYERI (Günther).

2 ♀♀, Masawan, Zamboanga; altitude 3,500 to 4,500 feet.

These two specimens were taken from the floor of the original forest. Both were gravid. One contained 18 unpigmented, cream-colored ovarian eggs; the other contained 20 eggs. The diameter of the eggs was about 3 mm.

RHACOPHORUS SURDUS (Peters).

1 ad. ♂, 1 ad. ♀ 1 juv. ♂, Dapitan Peak, altitude 6,000 to 6,500 feet.
1 juv. ♀, Masawan, Mt. Malindang; altitude 4,500 to 5,500 feet.

Our specimens agree very well with Inger's description of this species,[5] including the presence of the well-developed nuptial pads in the male. Examination under magnification showed the nuptial pads to consist of a number of small yellowish lumps as in *R. surdus*.

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[5] Inger, *op. cit.*, 387–389.

This is the first record of this species from the southern Philippines. It has been known previously to occur only in Luzon, in the Mt. Maquiling localities. The present record of this species from Mt. Malindang agrees with Inger's comments that "the Mount Maquiling record suggests that *surdus* may be limited to high elevations."[6]

RHACOPHORUS EMEMBRANATUS Inger.

1 ♀, Dapitan Peak, Zamboanga; altitude 5,100 to 6,500 feet.

Our present specimen was collected on a tree trunk about six feet high. It differed from the type in that it possessed a rudiment of a web between the first and the second fingers, a projecting snout, two tubercles between the eyes instead of on the eyelids, weak tubercles at the lateral edges of the forearm and the tarsus, and supernumerary tubercles on the foot. In addition it differed in coloration.

Its measurements are: snout to vent, 41 mm; head width, 17.9 mm; head length, 15.5 mm; lower leg, 21.8 mm.

The encapsulated eggs taken from the oviducts were cream-colored and measured from 3.2 to 3.9 mm in diameter, exclusive of the gelatinous capsules.

RHACOPHORUS LISSOBRACHIUS Inger.

1 ♀, Masawan, Zamboanga; altitude 3,500 to 4,500 feet.

The present specimen is the second known of the species. It differed from the type in the following characters: snout slightly projecting; absence of vomerine teeth; tympanum obscure; tubercles present above, not only on eyelids and occipital region; tubercles also present on lateral surface of forearm; and color pattern. The measurements are as follows: snout to vent, 34 mm; head width, 14 mm; head length, 13 mm.

PHILAUTUS ACUTIROSTRIS (Peters).

6 ♂♂, 3 ♀♀, 1 juv., Dapitan Peak, Zamboanga; altitude 5,100 to 6,500 feet.

4 ♂♂, 2 ♀♀, 2 juvs., Gandawan, Zamboanga; altitude 4,500 to 5,500 feet.

6 ♂♂, 9 ♀♀, 1 juv., Masawan, Zamboanga; altitude 3,500 to 4,500 feet.

The present specimens were collected on the ground and on low vegetation in original forests from 3,500 feet to 6,500 feet in elevation.

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[6] Ibid., 389.

The presence of ten gravid females in this series indicates that this species was breeding during the dates of collection (April to May, 1956). In fact, one pair in amplexus was captured on a tree about six feet above the ground. Two gravid females contained 12 and 14 encapsulated eggs in the oviducts when dissected. The eggs are cream-colored, unpigmented, and averaged 2.7 mm in diameter exclusive of the gelatinous capsules.

TABLE 1.—*Sexual dimorphism in snout-vent lengths and in lower leg/snout-vent proportions in Philautus acutirostris (Peters).*

Sex	No.	Mean	±	SE	Range	Diff. of means	t	n	P
♂	15	20.36	±	0.32	17.5-22.5	4.76	11.6	27	Highly significant.
♀	14	25.12	±	0.25	23.0-26-7				

LOWER LEG/SNOUT-VENT

Sex	No.	Mean	±	SE	Range	Diff. of means	t	n	P
♂	15	0.621	±	0.0069	0.561-0.665	0.031	3.0	27	Significant
♀	14	0.652	±	0.0073	0.610-0.696				

These specimens agree reasonably well with the description of *Philautus acutirostris* (Peters) by Inger.[7] However, there seemed to be intraspecific variation in the extent of the webbing in our present series. Inger states that the third and fifth toes are webbed to the distal edge of or slightly beyond the outer subarticular tubercle. In some of our specimens the webbing extended only to the base of center of the outer subarticular tubercle. Darker individuals usually did not show the crossbars on the limbs. Six specimens exhibited a mid-dorsal line from tip of snout to anus. Only one of the present series had vomerine teeth. There was sexual dimorphism in size and in lower leg snout-vent proportions (Table 1), as Inger suspected but was unable to show statistically on account of the lack of sufficient number of females in his samples.

KALOPHRYNUS PLEUROSTIGMA PLEUROSTIGMA Tschudi.

1 juv., Gumay, Zamboanga; altitude 2,700 to 3,000 feet.

This specimen was collected in original forest. It measured 30 mm from snout to vent and was an immature male.

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[7] *Loc. cit.*, 395–398.

TABLE 2.—*Altitudinal distribution of species.*

Species	Locality	Altitude
1. *Rana magna magna* Stejneger	Sibahay, Surigao	1,000 ft.
2. *Staurois natator* (Günther)	Sibahay, Surigao	1,000 ft.
3. *Ooeidozyga l. laevis* (Günther)	Sibahay, Surigao	500 to 1,000 ft.
4. *Rana signata grandocula* Taylor	Sibahay, Surigao	500 to 1,000 ft.
5. *Kalophyrynus p. pleurostigma* Tschudi	Gumay, Zamboanga	2,700 to 3,000 ft.
6. *Megophrys monticola stejnegeri* (Taylor)	Gumay, Mt. Malindang, Zamboanga	3,500 to 4,500 ft.
7. *Megophrys monticola stejnegeri* (Taylor)	Masawan, Mt. Malindang, Zamboanga	3,500 to 4,500 ft.
8. *Pelophryne lighti* (Taylor)	Masawan, Zamboanga	3,500 to 4,500 ft.
9. *Ansonia muelleri* (Boulenger)	Masawan, Zamboanga	3,500 to 4,500 ft.
10. *Rana parva* (Taylor)	Masawan, Zamboanga	3,500 to 4,500 ft.
11. *Cornufer meyeri* (Günther)	Masawan, Zamboanga	3,500 to 4,500 ft.
12. *Rhacophorus lissobrachius* (Inger)	Masawan, Zamboanga	3,500 to 4,500 ft.
13. *Philautus acutirostris* (Peters)	Masawan, Zamboanga	3,500 to 4,500 ft.
14. *Megophrys hasselti* (Müller)	Gandawan, Mt. Malindang, Zamboanga	4,500 to 5,000 ft.
15. *Rhacophorus surdus* (Peters)	Masawan, Mt. Malindang, Zamboanga	4,500 to 5,000 ft.
16. *Philautus acutirostris* (Peters)	Gandawan, Zamboanga	4,500 to 5,000 ft.
17. *Megophrys monticola stejnegeri* (Taylor)	Masawan, Mt. Malindang, Zamboanga	4,500 to 5,000 ft.
18. *Pelophryne lighti* (Taylor)	Gandawan, Mt. Malindang, Zamboanga	4,500 to 5,000 ft.
19. *P. lighti* (Taylor)	Masawan, Zamboanga	4,500 to 5,500 ft.
20. *Ansonia muelleri* (Boulenger)	Gandawan, Zamboanga	4,500 to 5,500 ft.

21. *Rana parva* Taylor	Gandawan, Zamboanga	4,500 to 5,500 ft.
22. *Pelophryne lighti* (Taylor)	Dapitan Peak, Zamboanga	5,100 to 6,500 ft.
23. *Ansonia muelleri* (Boulenger)	Dapitan Peak, Zamboanga	5,100 to 6,500 ft.
24. *Rana parva* Taylor	Dapitan Peak, Zamboanga	5,100 to 6,500 ft.
25. *Rhacophorus emembranatus* Inger	Dapitan Peak, Zamboanga	6,000 to 6,500 ft.
26. *Philautus acutirostris* (Peters)	Dapitan Peak, Zamboanga	4,500 to 5,000 ft.
27. *Rhacophorus surdus* (Peters)	Dapitan Peak, Zamboanga	6,000 to 6,500 ft.

ACKNOWLEDGMENT

We are indebted to Dr. Robert F. Inger, curator of reptiles and amphibians in the Chicago Natural History Museum, for checking our identification of *Rhacophorus emembranatus, Rhacophorus lissobrachius,* and *Rhacophorus surdus,* and for helping us in the comparative studies on *Pelophryne brevipes* and *lighti,* and *Rana parva* and *R. micrixalus;* and to Dr. Walter C. Brown, of the Natural History Museum of Stanford University, who kindly supplied data on the specimens of *Pelophryne lighti* now in the collection of that institution.

ANATOMY OF THE PROTOXYLEM ELEMENTS OF FOUR SELAGINELLA SPECIES *

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FOUR PLATES

Our knowledge of the anatomy of the primary xylem elements of *Selaginella* is based principally on the accounts of Russow,(11) Dangeard,(3) Harvey-Gibson,(10) Wardlaw,(14) and Duerden.(4) The foregoing writers, however, gave very brief accounts on the structure of the protoxylem elements. This paper presents observations made on certain unreported points on the anatomy of the protoxylem elements of *Selaginella;* such as, the number of protoxylem points present in the vascular strands, the types of cells and their wall sculpturings, the number of helices and the direction of wall deposition of the helical elements, the ontogenetic transition of the cells, and the order of development of the primary xylem as a whole.

MATERIALS AND METHODS

The materials used in this investigation consist of stems from four species of *Selaginella;* namely, *S. vogelli* Spring, *S. caulescens* Spring, *S. pallescens* (Presl) Spring, and *S. viticulosa* Klotz., from the greenhouse of the Horticulture Division, Department of Agronomy, Cornell University, Ithaca, New York, U. S. A. These species are generally alike in habit ranging from one-half to two feet in height. The stem is stiffly erect, simple or unbranched in the lower part and decompound in the upper part. The microphyllous leaves are heterophyllous and are borne dorsiventrally on the stem. In this investigation, samples were obtained from two levels of the main axis, one set of samples was taken from the base approximately two centimeters above ground level and the other from the tip portion approximately two centimeters below the growing point.

The histological procedures used are described in more detail in a previous publication of the writer.(15) The materials were fixed and killed in formalin-propionic-alcohol, washed in running water for several hours, dehydrated through the tertiary butyl alcohol series, embedded in paraffin, and microtomed at 11 microns. Both the safranin-fast green and safranin-aniline blue stain schedules for slide preparation yielded satisfactory results. As many slides as the writer thought were practicable were prepared for confirmation of his preliminary observations.

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* This represents the second portion of a paper(15) taken from a M.S. thesis submitted to the Department of Botany, Cornell University, Ithaca, New York.

OBSERVATION AND DISCUSSION

Number of protoxylem points.—Harvey-Gibson (10) classified the species which he studied into six types according to the number of stele present in the stem of *Selaginella,* thus: *(1) Martensii* type, with dorsiventral axis and banded stele; *(2) Oregana* type, with homophyllous leaves but with banded stele; *(3) Anomalous monostelic* type, with two stelar ribbons in the rhizome, banded stele with ventral cord in the erect shoot; *(4) Galeottei* type, regularly bistelic; *(5) Inaequalifolia* type, with three or more parallel stelar bands; and *(6) Lyallii* type, with solenostelic rhizome. The four species studied here are invariably monostelic and therefore fall under the *Martensii* type in Harvey-Gibson's classification. The protostele is simple and assumes the form of a thin ribbon (Plates 1 to 4, figs. 1 and 6) which according to Wardlaw: (14) " makes for a large surface of interchange between it and the adjacent living thin-walled tissues."

Harvey-Gibson (10) reported that the protostele of *S. vogelii, S. caulescens,* and *S. viticulosa* contains three protoxylem poles, two are marginal in position and one is dorsal in position but situated more or less in close proximity with one of the marginal strands. The observations of the writer conform with the original findings of Harvey-Gibson (10) as far as the number of protoxylem strands in the primary xylem of *S. caulescens* Plate 1 (px) and *S. viticulosa* is concerned. In some instances, however, as many as four and five distinct protoxylem groups are identifiable in the stele as observed in the tip portions of the main axis of *S. caulescens* and *S. viticulosa* (Plate 4, fig. 1 px).

As far as the basal portion of the main axis of *S. vogelii* is concerned, the observation of Harvey-Gibson is probably correct. The present writer found that in this species a variable number of protoxylem strands occur, ranging from two to six, and the occurrence is in the terminal portion of the axis of two dorsal protoxylem strands situated midway between the marginal points of the vascular bundle. Where two protoxylem strands occur, one is situated on each margin of the vascular bundle; where three are found the protoxylem areas are arranged similar to those of *S. caulescens* and *S. viticulosa*. Where four are present, three occur marginally and the fourth occurs dorsally; when there are five, three occur at the marginal ends, and two occur on the dorsal side (Plate 2 px).

A transverse view of the stele of *S. pallescens* is shown in Plate 3. The arrangement of the protoxylem strands in the primary xylem of this species, as illustrated in this plate, approaches closely those of *S. caulescens* and *S. viticulosa*.

Bower(1) writes that perhaps the peripheral position of the protoxylem was the more advanced feature than the central position as was also believed by others on comparative grounds.

Acccording to Harvey-Gibson(10) the two marginal protoxylem loci are formed by the fusion of the leaf-traces of the dorsal and ventral microphyllous foliage on either side of the stem. "The dorsal strand is derived from the fusion of the adjacent marginal protoxylem strands of the primary and secondary axes, the dorsal cord of one side not fusing with the adjacent marginal protoxylem strand until after the formation of a second dorsal cord from the fusion of a second branch on the opposite side" [Harvey Gibson.(10)] No attempt was made here to trace the origin and formation of such protoxylem strands in support of the present observation. It must be borne in mind, however, that the disposition of the protoxylem points is determined and affected roughly by the number of leaf-traces inserted on the vascular cylinder in the main axis and the degree of fusion occurring between these traces themselves.(15)

Cell types.—The types of cells in the protoxylem strands are similar to those of the other species investigated by the writer. For illustrations, the reader is referred to the first portion of this paper.(15) Longitudinal sections show that the protoxylem strands are histologically composed of tracheids with annular, "transitional" (elements with combined annular and helical thickenings), and helical secondary wall thickenings in varying proportions depending upon the relative sizes of the protoxylem strands in each species. Where strands are comparatively large, the greater bulk of the tracheary elements is represented by the helical cell types. The "transitional" elements are rare in *S. caulescens.* No parenchyma cells are present in the protoxylem strands.

It is difficult to determine the number of cells in the protoxylem strands in the stele. As commonly observed with very few exceptions Plate 4, figs. 3 and 5 (px) in these species the component cells are darkly staining and have very small transverse diameters. Additional difficulty in ascertaining the number of cells is introduced by the occurrence of lacunæ in some protoxylem strands especially in *S. pallescens, S. caulescens* (Plate 4, fig. 4 la), and *S. viticulosa* (Plate 4, fig. 2 la).

The first-formed protoxylem elements show various degrees of distortion, tearing, and stretching, depending upon the time of their appearance during the differentiation of the protoxylem strands in relation to the elongation of the stem. In the annular and "transitional" elements, the ringlike secondary wall thickenings are commonly disoriented from their original positions, subsequently becoming widely separated from one another and tilted in various directions. In the helical elements, the helices are frequently longitudinally stretched and in the more exaggerated cases, the helices become steeply wound or even straightened out. In both these cells, the thin distended primary walls collapse, resulting in the further disorientation of the thickenings of these elements and eventually in the subsequent complete or partial closure of their lumina. In *S. caulescens* (Plate 4, fig. 4), *S. pallescens,* and *S. viticulosa* (Plate 4, fig. 2), these elements are completely crushed or obliterated. Fragments of secondary wall thickenings as a result of distortion are sometimes visible in transverse sections. The remnants of such fragmented elements have completely disappeared in certain instances, and in their places small lacunæ (Plate 4, figs. 2 and 4 la) have appeared. No such lacunæ are formed in the protoxylem strands of *S. vogelii* (Plate 2). The present writer, in an earlier publication, speculated that the manner in which the protoxylem lacunæ are formed in *Selaginella* closely parallels those which have been described for *Zea*(8, 9) and other monocotyledonous plants and *Equisetum*. (5, 7)

The later-differentiated cells in the protoxylem strands, which are commonly represented by helical elements, are only slightly stretched or may even remain closely coiled. The cells have comparatively larger transverse diameters with slightly more extensive secondary wall thickenings than those cells formed earlier. The closely coiled condition among the later-formed elements is probably the original condition assumed by the earliest-formed ones before they become longitudinally stretched. It is probable that these changes are brought about by the influence of stresses resulting from the elongation of the stem as a whole.

The rings and helices in the unstretched condition appear to be firmly attached to the thin distended primary wall by means of more or less "nodule-like" or "lenticular" thickenings at points where contact is established between them. The cytological aspects of secondary wall patterns in the protoxylem elements of *Selaginella* have not been included in this study.

Number of helices and direction of wall deposition in helical elements.—For illustrations, the reader is referred to the first portion of this paper.(15) Only one helix is present in each helical element in *S. vogelii,* one or two in *S. caulescens, S. pallescens,* and *S. viticulosa.* When two helices are present, they are more or less regularly oriented spirally, however, they are not parallel to each other but make contact with the primary wall on opposite sides of the cell at a given level. The helices appear to be laid down in clockwise, or counterclockwise fashion, or in a combination of both fashions.

Ontogenetic transition of cells.—Beginning with the earliest-formed annular protoxylem cell or cells, whether the xylem is exarch or mesarch in development, the secondary wall thickenings are generally laid down in the successively formed elements as "transitional" or helical, or both, in the ontogenetic series.

Several variations as regards the ontogenetic transition of the protoxylem cells in the same longitudinal series occur in *S. vogelii.* These observed variations may be grouped into categories which are designated for the sake of simplicity and convenience as Groups I, II, III, IV, V, and VI. In defining these groups, the ontogenetically first-formed annular cell or cells are taken as the index of reference in relation to the differentiation of the later-formed protoxylem elements in a given strand toward the phloem and the xylem sides, thus:

Group I. Beginning with the earliest-formed annular elements the secondary wall thickenings are generally deposited in the successively formed elements as "transitional" and helical.

Group II. In this type, the earliest formed annular cell is followed immediately by metaxylem element or elements on both sides. The "transitional" and helical cells are omitted in the ontogenetic series.

Group III. This is characterized by the presence of metaxylem elements which are differentiated toward the phloem side and the "transitional" and helical elements toward the xylem side. The "transitional" and helical elements are not differentiated on the phloem side of the first annular cell formed.

Group IV. In this type, only the "transitional" element is differentiated towards the phloem side and only the helical cell is differentiated toward the xylem side of the first-formed annular cell or cells.

Group V. "Transitional" and helical elements are differentiated toward the phloem side in that order but only the helical element is differentiated toward the xylem side.

Group VI. Here, only the "transitional" cell is differentiated on both sides of the first-formed annular cell or cells.

Differentiation of the primary xylem.—Russow(11) states that the vascular strands of the stem of *Selaginella* consist of one or more marginal protoxylem groups and centripetally developed metaxylem of scalariform tracheids. Dangeard(3) illustrated but did not distinguish the protoxylem and metaxylem in the stele of the twenty-eight species he investigated. Bower, (1, 2) Eames,(6) Schoute,(12) and Smith,(13) hold that the xylem is essentially exarch in development, with the exception, perhaps, of *S. spinosa* which have been reported to possess both the exarch and endarch xylem differentiation.(1, 2, 12) Whether the endarch xylem designated in this particular species is authentic or not has not been verified and the writer does not propose to settle it here. The primary xylem of the four species investigated in this paper exhibits exarch as well as mesarch differentiation. The exarch xylem generally occurs in the region occupied by the dorsal protoxylem strands (Plate 4, fig. 8) with few exceptions. Mesarch xylem is expressed variously in these species ranging from weakly mesarch to decidedly mesarch type (Plates 1 to 4, figs. 2 to 5, and 7). The mesarch xylem is composed of small darkly staining cells grouped into well-defined strands and is situated on the "morphologic" interior of the primary xylem as a whole. There are only a few metaxylem elements on the phloem side of the primary xylem (Plate 4, figs. 2 to 5, and 7). Eames and

MacDaniels(7) however, state that "where development is such that both centripetal and centrifugal xylems are formed, even though the amount of one type is very small, the xylem is mesarch." Recently, the writer(15) reported the occurrence of mesarch xylem in some species, the fullest expression of which is seen in the stems of *S. martensii* Spring, *S. uncinata* Spring, *S. braunii* Baker, and *S. selaginoides* (L.) Link. Mesarch xylem differentiation has not been reported in the genus by previous workers. A survey on the occurrence of the three fundamental types of primary xylem differentiation (exarch, mesarch, and endarch) in the different groups of vascular plants has been undertaken.(15) The data accumulated were utilized in interpreting the phylogenetic significance of these xylem types in an attempt to indicate the probable position of *Selaginella* in the phylogenetic scale relative to the position of the other vascular plants, both fossil and extant, on the basis of primary xylem differentiation. The evidence seems to indicate that the exarch xylem proposed to be the most primitive is probably inconclusive. Available facts, however, do not entirely negate this interpretation; but it is not unreasonable nor improbable to propose that endarch and mesarch xylems as primitive types also, in view of their reported occurrence in the lower vascular plants including *Selaginella*.

SUMMARY

The number of protoxylem loci or strands in the stele of the stem of the four species of *Selaginella* is variable: 3 in *S. pallescens*, 3 to 4 in *S. caulescens*, 3 to 5 in *S. viticulosa*, and 2 to 6 in *S. vogelii*.

The protoxylem strands contain annular, "transitional," and helical elements with reference to the character of their secondary wall sculpturings. Protoxylem lacunæ occur in the protoxylem regions of these species except in *S. vogelii*.

The helical elements of *S. vogelii* invariably contain one helix; one or two in all others. They are laid down in a clockwise, or counterclockwise pattern, or in a combination of both patterns.

In general, beginning with the earliest formed annular cells, the secondary wall thickenings are laid down in the successively formed elements as "transitional" or helical, or both, in the ontogenetic series.

The primary xylem of the species investigated exhibits exarch and mesarch differentiation. The occurrence of mesarch xylem development in these species has not been reported by previous workers.

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ILLUSTRATIONS

[Abbreviations: *px*, protoxylems; *mx*, metaxylem; and *la*, protoxylem lacuna.]

PLATE 1

Transverse view of the stele of *S. caulescens* taken from the basal portion of the main axis approximately two centimeters above ground level.

PLATE 2

Transverse view of the stele of *S. vogelii* taken from the main axis approximately two centimeters below the shoot apex.

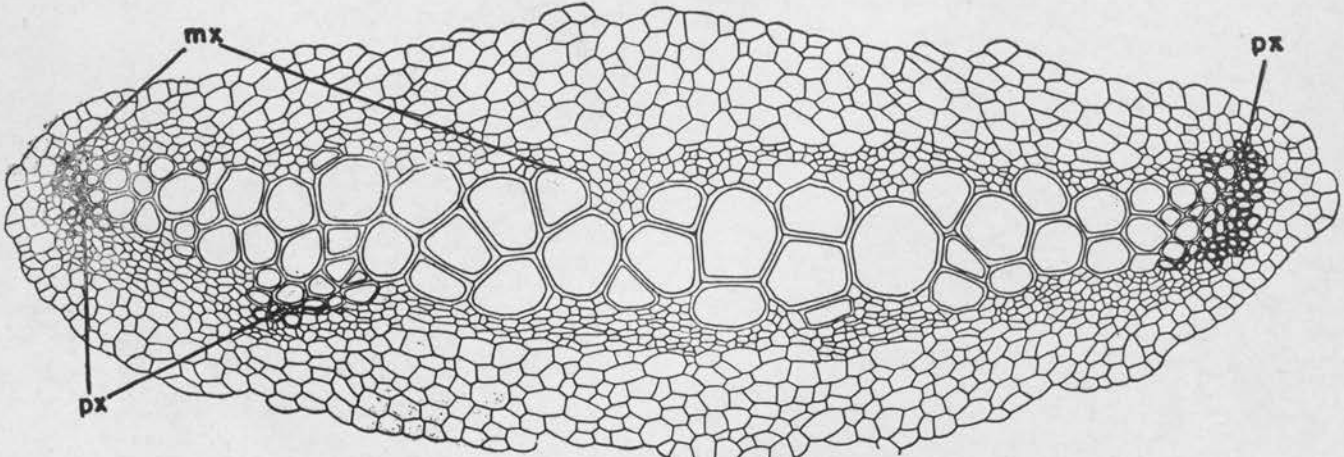
PLATE 3

Transverse view of the stele of *S. pallescens* taken from the tip portion of the main axis approximately two centimeters below the shoot apex.

PLATE 4

FIG. 1. Transverse view of the stem of *S. viticulosa* under low magnification.

2. Transverse view of a portion of the stele of *S. viticulosa* under oil immersion.
3. Transverse view of a portion of the stele of *S. caulescens* under oil immersion.
4. Transverse view of a portion of the stele of *S. caulescens* under oil immersion.
5. Transverse view of a portion of the stele of *S. caulescens* under oil immersion.
6. Transverse view of the stem of *S. pallescens* under low magnification.
7. Transverse view of a portion of the stele of *S. pallescens* under oil immersion.
8. Transverse view of a portion of the stele of *S. pallescens* under oil immersion.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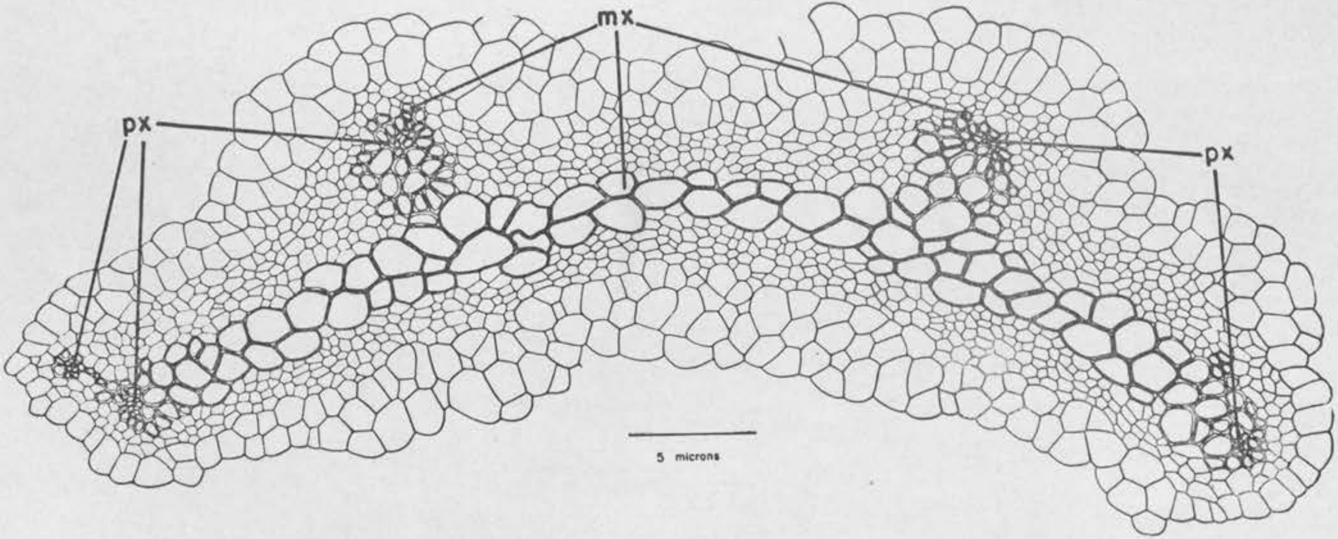
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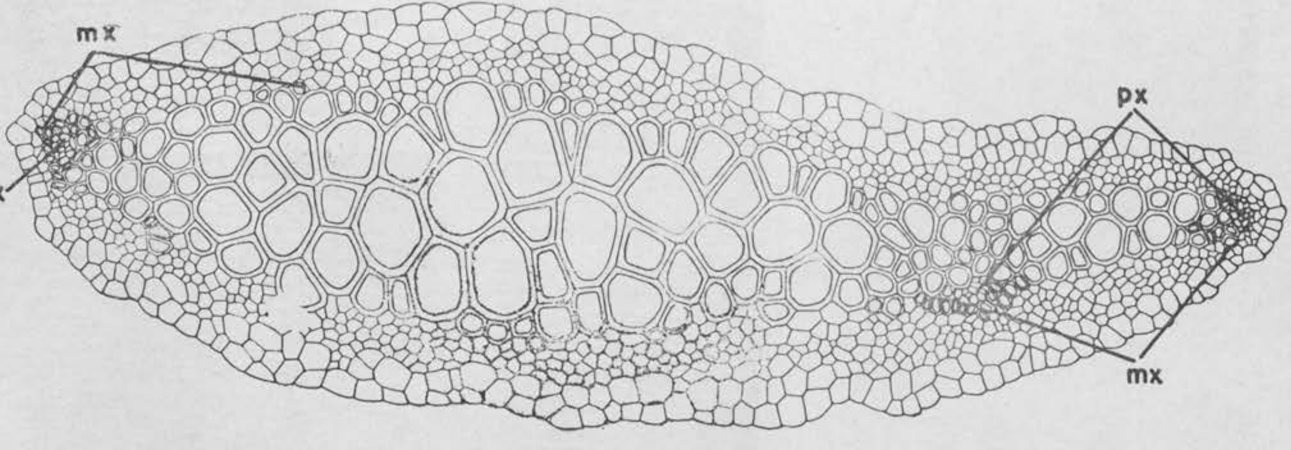
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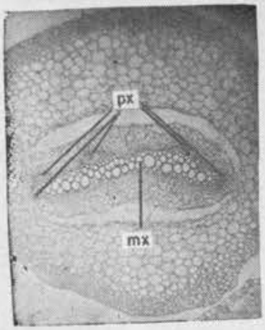

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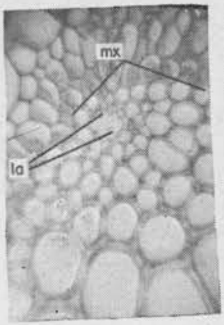

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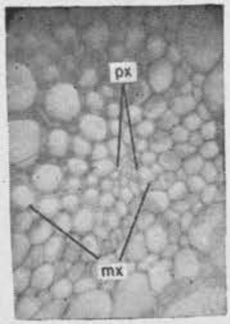

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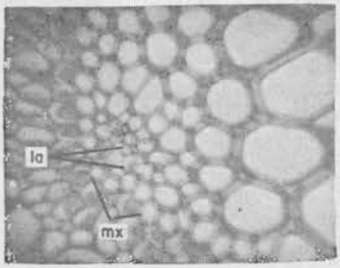

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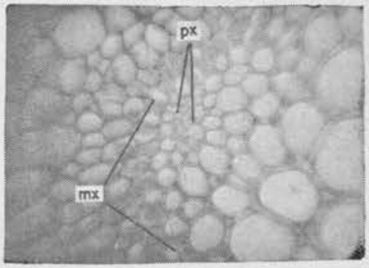

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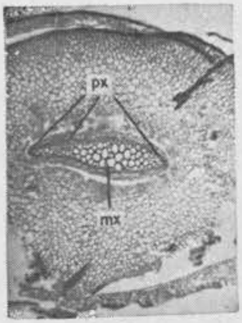

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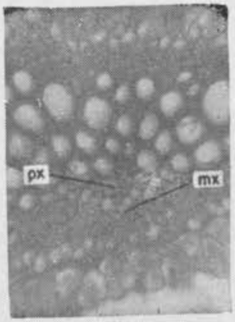

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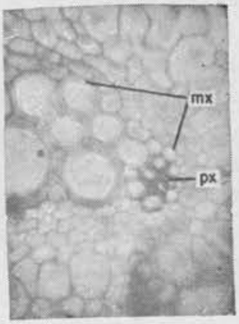

8

THE EFFECTS OF HYPOGLYCEMIA INDUCED BY AGENTS OTHER THAN EXOGENOUS INSULIN ON DUODENAL MOTILITY IN DOGS UNDER MORPHINE-CHLORALOSE ANESTHESIA

II. LAGERSTROEMIA SPECIOSA (LINN.)

By Ruben D. Buñag, Benjamin M. Rigor, Leonardo G. Tan Gatue,
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University of the East Ramon Magsaysay Memorial Medical Center
Quezon City

ONE PLATE

Lagerstroemia speciosa (Linn.) is a deciduous tree that is found in abundance almost throughout the Philippines.(12) Locally known as *banaba*, this plant, among many Philippine medicinal plants, is known to contain hypoglycemic principles. (9, 10) Found in different parts of the plant, this principle exists in greatest amount in the old leaves and ripe fruits.(4) The present study was made to determine the effects of hypoglycemia induced by intravenous injection of banaba infusion on duodenal motility in anesthetized dogs, following the same procedure described in our previous reports.(3, 4)

MATERIALS AND METHODS

Ten normal, mongrel dogs of both sexes with an average weight of 9.0 kg (16 to 11 kg) were used in our experiments. The dogs were fasted for 16 to 18 hours but had access to water. Surgical and experimental procedures were performed while they were under morphine-chloralose anesthesia (morphine sulfate, 10 mg/kg given subcutaneously; and chloralose, 50 mg/kg given intravenously).

The dogs were assigned into two random groups as follows:

Control group.—The four dogs in this group were anesthetized and surgically prepared in the same manner as the dogs in the second group but without receiving any banaba infusion.

Banaba group.—The six dogs in this group were given intravenously 0.5 gm/kg of mature, dried banaba leaves in the form of a 20 per cent infusion after suitable control records had been taken. The infusion was prepared following the procedure recommended by Martin and Cook(11) using 20 gm of leaves for every 100 ml of sodium chloride solution.

Blood samples of approximately 2 ml each were drawn from an exposed femoral vein of each dog at periodic intervals throughout all the experiments. The total number of blood samples taken ranged from 7 to 14 for each dog. In each dog, duplicate samples of blood were drawn from an external saphenous vein prior to the administration of the anesthetic. In the control group, samples of blood were taken at 30- to 60-minute intervals for 5 to 6 hours following anesthetization. In the dogs given banaba infusion, 2 samples were drawn at 15- to 30-minute intervals prior to the injection of the infusion; subsequent samples were drawn every 15 to 30 minutes for the first two hours after injection and then hourly for the next two hours.

Surgical preparation of the animals, method of blood sugar determination and evaluation of duodenal tracings have previously been described.(3, 4)

RESULTS

Control group.—A sustained elevation of the blood sugar level was observed in all four dogs. The elevation was maintained throughout the entire course of the experiments, up to the time last blood samples were extracted, six hours after anesthetization. Most of the hyperglycemia was due to the anesthetic agents used and the subsequent operative procedures performed, and was presumed to be of sympathoadrenal origin.(4)

Tracings of duodenal motility showed a marked degree of activity in all four dogs. Visual inspection of the records showed a predominance of non-propulsive types of movement in most instances, with propulsive waves occurring very rarely, if at all. The type of duodenal movement seen in these animals was probably influenced in part by the morphine used as preanesthetic medication. Morphine has been reported to produce an increase in tone and non-propulsive movements with a prominent diminution of propulsive waves.(1, 6, 7, 13) Surface area measurements were made with a polar planimeter at points corresponding to the blood sugar determinations in each kymogram. Changes in area of total duodenal contractions during the period of observation were insignificant.

Banaba group.—An anesthetic hyperglycemia was observed in all six dogs prior to intravenous injection of banaba infusion. Blood sugar changes that took place in these dogs during anesthesia and following intravenous injection of banaba infusion are shown in Table 1 and in Plate 1, fig. 1. A marked fall in blood sugar was noted in all animals following intravenous injection of banaba infusion. The lowest point in the fall occurred at an average of 78 minutes after injection; the earliest nadir occurred 45 minutes, and the latest 120 minutes after injection. At the nadir, the blood sugar fell an average of 48 per cent from the anesthetic level.

TABLE 1.—*Blood sugar values (milligrams per cent) of anesthetized dogs given banaba infusion intravenously.*

Dogs	Time in hours								
	Control	—0.5	0	0.5	1.0	1.5	2	3	4
1	64	60	58	54	36	*27	44	41	51
2	50	51	54	36	*27	28	29	33	33
3	56	68	77	63	38	*35	40	48	63
4	62	90	76	*54	54	62	63	65	71
5	70	83	83	67	*27	43	45	45	70
6	76	128	118	71	70	70	*68	82	90

* Nadir of blood sugar fall.

Increased duodenal motility was noted in all six dogs; portions from a typical tracing are shown in Plate 1, fig. 2. Hypermotility was however, not constantly maintained since short periods of relative quiescence occurred at irregular intervals in most instances even at the peak of the motor response. Except for the sudden drop in baseline of duodenal contractions during the first minute or so after injection of the infusion (produced by the manipulations incident to intravenous injection), there was no inhibitory phase preceding the increase in motility. Pilot experiments made on isolated intestinal strips from unanesthetized dogs showed that the infusion used did not have any appreciable stimulant nor spasmolytic action on the intestinal smooth muscles in concentrations ranging from 1:250 to 1:1000.(5)

Surface area measurements were made as previously described for the control animals. Data obtained from the individual animals are shown in Table 2 and Plate 1, fig. 1.

DISCUSSION

We have previously stated that in determining the reliability of hypoglycemia as a stimulus for duodenal motility, two main factors should be considered: first, the adequacy of the reduction in blood sugar level and, second, the rate or rapidity of development of the hypoglycemia. In order to be adequate as a stimulus, there should be a reduction of about 50 per cent from the anesthetic level and such a reduction should be attained within a relatively short period of time.(3, 4) Both of these requirements are satisfied by intravenous injections of banaba infusion which produce a 48 per cent fall within 78 minutes after injection. An increase in duodenal motility as encountered in our series of dogs following intravenous injection of banaba infusion is therefore to be expected.

TABLE 2.—*Surface area (square centimeters) of duodenal contractions in anesthetized dogs given banaba infusion intravenously.*

Dogs	Time in hours						
	Control	0.5	0.1	1.5	2.0	3.0	4.0
1	23.5	27.4	29.9	30.1	28.2	32.0	31.3
2	8.5	14.8	13.9	18.0	16.8	17.8	21.0
3	8.2	10.8	11.5	12.3	13.4	14.9	11.2
4	5.5	7.8	7.3	7.2	13.4	8.6	10.4
5	11.6	12.9	14.6	13.8	12.4	13.9	12.9
6	8.9	7.8	15.9	18.9	20.3	5.4	5.8

An increase of gastrointestinal contractions has been reported to occur during the hypoglycemia induced by hepatectomy.(2) Based on this report, the suggestion has been made that hypoglycemia induced by agents other than exogenous insulin can also be an adequate stimulus for increased gastrointestinal motor activity. Our present findings are in agreement with this contention.

SUMMARY AND CONCLUSIONS

Hypoglycemia occurred in normal anesthetized dogs given banaba infusion intravenously. The hypoglycemia induced was an adequate stimulus for duodenal hypermotility. The data presented support the belief that hypoglycemia induced by agents other than exogenous insulin can be adequate as a stimulus for increased duodenal motor activity.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Changes in blood sugar and surface area of duodenal contractions in dogs given banaba infusion. Values represent mean of six determinations. Black portions of bars represent increase in surface area of duodenal contractions.

2. Typical duodenal motor response to intravenous injection of banaba infusion: (*a*) Control tracing prior to injection. (*b*) Banaba injected intravenously, 0.5 gm/kg (*c*) Peak of motor response, 60 minutes after injection.

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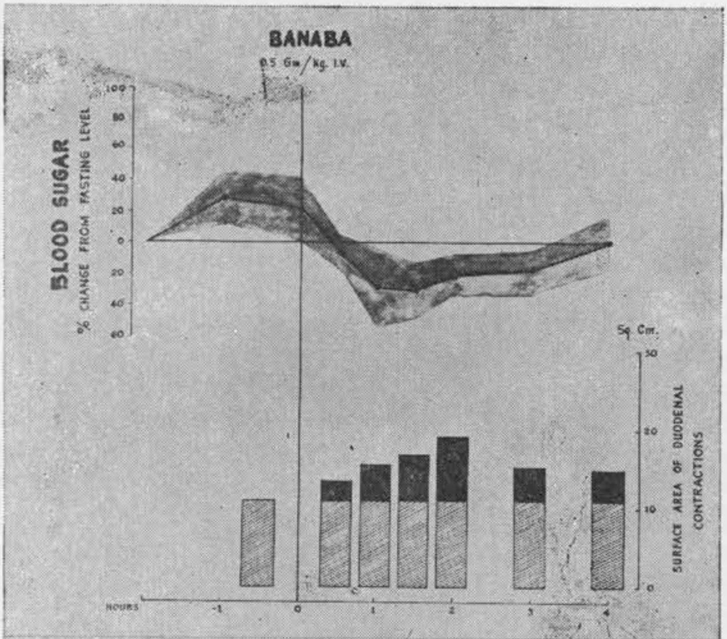
BANABA
0.5 Gm/Kg. I.V.
BLOOD SUGAR
% CHANGE FROM FASTING LEVEL
100
80
60
40
20
0
20
40
60
Sq. Cm.
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SURFACE AREA OF DUODENAL CONTRACTIONS
HOURS
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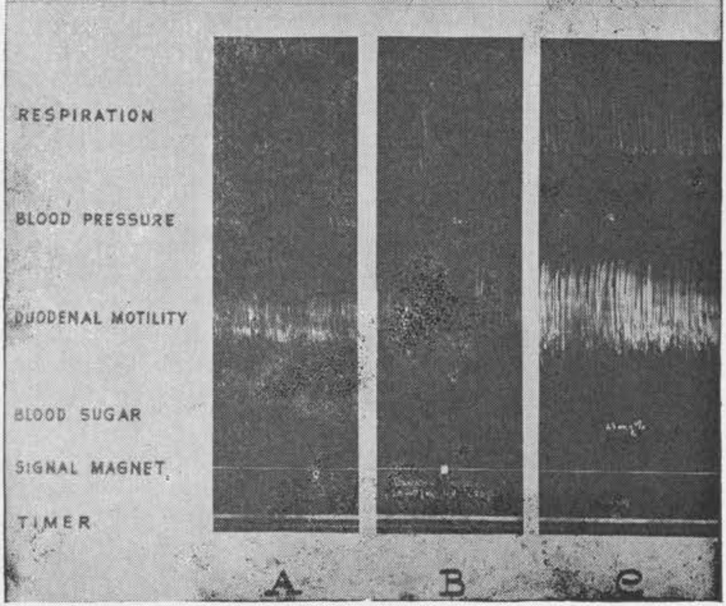
RESPIRATION
BLOOD PRESSURE
DUODENAL MOTILITY
BLOOD SUGAR
SIGNAL MAGNET
TIMER
A
B
C

2

PLATE 1.

PULMONARY PARAGONIMIASIS IN THE PHILIPPINES

REPORT OF A CASE DISCOVERED AT AUTOPSY WITH PARAGONIMUM AND SCHISTOSOMA LESIONS

By Carlos Monserrat and Amparo Buenaventura
College of Medicine, University of the Philippines

FOUR PLATES

Paragonimiasis in the Philippines was first studied by W. Musgrave,(5) who reported in 1907 a total of 17 cases among Bilibid Prison inmates in Manila. Eight of these cases were confirmed by autopsy. In Philippine medical literature not more than 50 cases have been reported from 1907 to 1956. In this literature about 10 other cases were cited in the form of verbal communications. It should be added that the cases reported were studied from the clinical viewpoint. With the exception of the eight cases of Musgrave confirmed by autopsy in 1907 and the case of Barrera in 1938,(6) the pathological records of which in the Department of Pathology, College of Medicine, University of the Philippines, were destroyed during the second World War, no other pathological record of paragonimiasis, either accidentally discovered at autopsy or confirming a clinical diagnosis exists. Illustrations in appropriate textbooks of the various gross and microscopic lesions of paragonimiasis in human autopsies show inadequate descriptions.

In this paper the authors report a case of extensive pulmonary paragonimiasis with concomitant *Schistosoma japonicum* infection in a native from Leyte Province, Philippines, accompanied by gross and microscopic pictures of the lesions of the double infection, discovered at autopsy. The patient showed symptoms on intra-cranial hemorrhage, and the clinical impression was brain schistosomiasis, since the patient came from a region highly infested with *Schistosoma japonicum* and since it is not infrequent to find patients coming to Manila from areas endemic of schistosomiasis, with symptoms of intra-cranial hemorrhage. In our case, however, the *Paragonimus* infection was never suspected in the patient.

PARAGONIMUS WESTERMANII

The fluke *Paragonimus westermanii* is somewhat oval in shape and reddish-brown in color. The size of mature specimens varies. Musgrave(5) sets the following measurements as limits of the variations: 0.008–0.020 × 0.004–0.009 × 0.002–0.006.

Microscopically, it shows, in the body, scalelike integumental spines. This parasite may invade and produce lesions in various tissues of the human body, particularly in the lungs, causing the disease known as pulmonary paragonimiasis or chronic hemoptysis.

Paragonimiasis is a widely distributed disease being specially prevalent in the Far East, where endemic regions have been recognized in the Philippines, Formosa, Japan, Korea, Central China, and probably the Dutch East Indies. It is rarely found in India, Africa, and South America.

Besides man, the dog, cat, pig, sheep, goat, tiger, panther, leopard, wild cat, wolf, fox, beaver, wolverine and civet cat, are reservoirs of paragonimiasis. These animals acquire the infection through the metacercaria by eating infected raw fresh-water crabs or crayfish. Man acquires the disease by eating these either salted or wine-soaked. In the latter case, while the wine kills the crustacean the metacercaria remains alive for several hours, as only by roasting or heating the crustacean at 55°C for 5 minutes will kill it and prevent infection. Drinking of infected water containing the metacercaria is another source of infection.(3)

Life cycle of P. westermanii.—In the life cycle of paragonimus, the two intermediate hosts in the Philippines are the small fresh-water snail and the crab or crayfish which were discovered by Tubangui in 1941.(9) He found larval stages of *Paragonimus* in a number of snails and crabs collected from streams in the Municipality of Casiguran, Province of Sorsogon. According to him, the snail *Brotia asperata* is the first intermediate host and the fresh-water crab *Parathelphusa (Barythelphusa) mistio* is the second host.

More recently Yogore,(12) a collaborator of Tubangui, made a general survey and study on the naturally infected snails and crabs from the mountain streams of the same endemic area of Casiguran. His work resulted in the identification of the crab as *Parathelphusa (Barythelphusa) grapsoides.*

Development of metacercaria in the human body.—The encysted metacercaria, once ingested in the human body with the raw meat of an infected crab or crayfish, is digested in the stomach. The metacercaria is freed and penetrates the wall of the upper jejunum, reaching the peritoneal cavity.

From there, it invades the diaphragm, the pleural space, and reaches the lungs. In these organs, the metacercaria develops into adult worms, which are found at autopsy inside cystic nodules and burrows in the parenchyma together with numerous ova laid by the hermaphrodite parasites. The burrows are usually communicated with the bronchial tree and so some of the ova may pass to the lumen of the bronchi and are expectorated in the sputum. Other ova are swallowed and may appear in the stools.

To continue the life cycle of the parasite, the discharged ova should reach fresh-water ponds or rivers where each ovum liberates its ciliated miracidium within 17 to 20 days. In the water it penetrates the first intermediate host to develop into larva cercaria. To complete its life cycle, in due time the cercaria leaves the snail to penetrate and develop into metacercaria in the second intermediate host.

CASE REPORT

Clinical abstract—This is a case of a 20-year-old man from Leyte Province who was admitted in an unconscious condition and stayed only for one hour in the hospital. He had severe headache one week before death, which was partially relieved by taking aspirin. On the 3rd day, he accidentally fell and bumped his head on the cement floor, and since then he grew progressively worse until he became unconscious.

Physical examination revealed dilation of pupils (7 to 8 mm) which were not reactive to light. Breathing was stentorous. There was no external evidence of injury on the head; no neck rigidity; and negative findings in the chest and abdomen. X-ray of the skull showed no evidence of fracture.

Clinical impression.—Cerebral vascular accident (?) Schistosomiasis, brain (?) Intracranial hemorrhage, traumatic (?)

Autopsy (*abstract*).—No. *54–1033* (*Doctor Buenaventura*).—At autopsy both lungs showed thickened fibrous visceral pleura. On palpation, vari-sized nodules, ranging in consistency from that of a definite cyst to one of consolidation, could be appreciated.

Cut surfaces of the lungs showed cystic areas with fibrous walls, some of which were definitely connected to the bronchial tree. Some of these cystic cavities contained small brown oval living flukes, which the parasitologists identified as the lung fluke, *Paragonimus westermanii.*

Cut section of the solid nodules revealed a brown surface in the center of which could be seen irregular, small, necrotic areas from which brownish, slightly thick material could be scraped out. This material when examined under the microscope revealed the presence of paragonimus eggs.

The heart was normal in size, pale, with irregular whitish areas scattered indiscriminately over the "visceral pericardium" of the right auricular appendage. Large whitish patches were seen also over the anterior and posterior walls of the visceral pericardium of the right ventricle and several ecchymotic patches on the posterior wall (subepicardially) of the left ventricle.

The liver was normal in size and weighed 1,304 gms. There were deep scars scattered here and there on the surface. The abdominal surface of the diaphragm was adherent to the dome of the right and left lobes. Cut surface of the liver showed broad bands of fibrous tissue, especially around the large portal vessels, which divided the organ into irregular large nodules.

The gastro-intestinal tract appeared normal except for slight-to-moderate congestion, especially of the duodenum, and the presence of "large, rather firm mesenteric, perigastric and para-aortic lymph glands."

In the peritoneal cavity an "enlarged, one-inch omental gland" was found. This section contained brownish fluid similar to that seen in the cystic spaces of the lungs. Another cyst of similar size was seen attached to the peritoneal surface of the anterior abdominal wall.

The serosal surface of the entire colon and around the caecum was studded with vari-sized brown granular nodules which were considered as probable sites of "infiltrations with schistosome eggs."

The spleen was enlarged with fibrous adhesions on the capsule. It weighted 307 gms. The cut surface was beefy red, firm, with slight prominent trabeculæ.

The kidneys and urinary bladder were essentially normal.

The femur marrow showed areas of reddish discoloration indicative of hemopoietic activity.

The marrow of the flat bones was also red.

The convolutions of the brain were flattened and the sulci were shallower than normal. There was a small (1 to 2 cm in diameter) subarachnoid hemorrhage over the right parietal lobe. This area was slightly fluctuant. The blood vessels were not arteriosclerotic.

Serial section of the brain after fixation in formalin showed a large cavity in the right cerebral hemisphere. It extended from the genu to the splenicum of the corpus callosum. This cavity had caused enlargement of the right cerebral hemisphere. The cavity contained clotted blood and thick brownish-gray fluid material. There was no capsule, the wall being composed of hemorrhagic and necrotic brain tissue. The floor of the cavity was formed by the internal capsule which it had displaced downwards; the roof, by the cerebral white matter; its medial wall by the corpus callosum, which it had displaced upwards; and the lateral wall by the extreme capsule. There was no rupture of the walls into the ventricles or external surface. The contents of the cavity were macerated for the presence of eggs or adult worms. None were found.

MICROSCOPIC NOTES

The important histologic findings in this case were found in the lungs, abdominal wall, liver, jejunum, colon, appendix, and brain.

In the lungs, two types of lesions were found. One was due to the presence of adult worm *Paragonimus* in the parenchyma; the other, to the presence of *Schistosoma japonicum* ova.

Two of the lung-tissue sections showed cross-sections of the adult *Paragonimus* worms with various structures in their bodies. The worms in these sections were enclosed by a thick layer of neutrophils and eosinophilic lecucocytes with few mononuclear cells. The immediately adjacent lung-tissue was necrotic; but farther away, the lung architecture was more intact but with the alveolar spaces filled with an exudate composed of eosinophils, macrophages and round cells. There was no fibrin in the alveolar spaces (areas of pseudo-pneumonia).

In other sections of the lung there were nests of *Schistosoma japonicum* eggs which were oval in shape, with sharply pointed poles and brown, coarsely granular contents. Most of these eggs were collapsed and undergoing resorption. Some of them had been penetrated by giant cells. These eggs were surrounded by a dense layer of round cells, fibroblasts, and few eosinophils. There were some giant cells of the Langhan's type.

The other lung section which contained neither worms nor eggs were involved in a chronic and acute inflammatory process. The exudate was similar everywhere and consisted of eosinophils, neutrophils, round cells, macrophages and a few giant cells. This type of exudate was found in the alveolar spaces, in the septæ, causing thickening in the peribronchial and perivascular spaces. Some of these areas had necrotic centers (abscess formation). Many bronchiles contained dense, homogeneous, pink material in their lumen.

In the liver, there were numerous *S. japonicum* eggs in the form of oval bodies with a brown skull and granular, amorphous, brownish contents. These eggs were found in the portal areas, in the capsule, in the bands of fibrous tissue that traversed the parenchyma and in the lobules themselves. These eggs were usually surrounded by round cells, fibroblasts and occasional foreign body giant cells. In the liver lobules, they caused necrosis, eosinophilic and lymphocytic infiltration and proliferation of fibroblasts.

In the jejunum, colon, and appendix similar nests of *S. japonicum* eggs were found in the submucosa which was very much thickened and formed by dense collagenous tissue. In the appendix, the eggs were found in all the layers of the organ except in the mucosa.

The omental cyst in the abdominal wall had 3 layers. The inner layer was composed of large, pale staining cells with abundant pale pinkish cytoplasm. The middle layer was made up of dense collections of cells of varying sizes, lymphocytes, mononuclears, macrophages and some eosinophils. The outermost and thick layer was composed of dense collagenous tissue with fibroblasts and fibrocytes. At the edges of the cyst, there were also many blood vessels surrounded by lymphocytes. The cavity of the cyst contained some pinkish granular material with numerous operculated eggs of *P. westermanii.*

Sections of the brain taken from the wall cavity showed hemorrhages, small areas of necrosis with polymorphonuclear infiltration, edema, areas of liquefaction and pigment-laden macrophages. (Histo-diagnosis: Brain abscess with hemorrhage.)

FINAL ANATOMICAL DIAGNOSIS

Paragonimiasis (*P. westermanii*), extensive, lungs, bilateral; adhesive pleurities, bilateral; *Paragonimus* cysts anterior abdominal wall and greater omentum; brain abscess with cavity formation and old hemorrhage, right cerebral hemisphere; focal chronic epicarditis.

Schistosomiasis, severe, liver, small and large intestines, appendix; splenomegaly; pallor generalized; hyperplasia, bone marrow.

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ILLUSTRATIONS

PLATE 1

Gross pathologic change in the lung in pulmonary paragonimiasis. Note cut surface of the lung showing the presence in the upper lobe of 2 large cystic cavities surrounded by good amount of bluish translucent fibrous tissue. At autopsy the cavities contained anchovylike colored fluid, which microscopically revealed numerous *Paragonimus* ova. Note also around these cavities the presence of various adult flukes of *Paragonimus* which are oval in shape, reddish-brown in color.

PLATE 2

FIG. 1. Low-power magnification of the cross section of a *Paragonimus* fluke in the lung with the characteristic exudate around the parasite consisting of a thick layer of neutrophils, eosinophils and few mononuclears.

2. Low-power magnification of a cross-section of another parasite with more structures in its body.

PLATE 3

FIG. 1. Low-power magnification of the omental cyst of *Paragonimus* in the abdominal cavity found at autopsy. Histologically the cyst is composed of 3 layers: the inner containing a large pale epithelial cell with abundant pale pink cytoplasm; the middle, made of a dense collection of lymphocytes, mononuclears, macrophages and some eosinophils; and the outer composing of dense collagenous tissue with fibroblasts and fibrocytes.

The cavity of the cyst contained some pink granular material with numerous operculated eggs of *Paragonimus.*

2. High-power magnification of the cellular reaction due to the presence of *S. japonicum* eggs in the liver of patient. Note numerous *S. japonicum* ova at center, appearing as oval bodies with brown shell and granular brown amorphous content, surrounded by round cells, some fibroblasts and few giant cells; some of them collapsed, undergoing resorption.

PLATE 4

FIG 1. High-power magnification of a pseudotubercle in the lung due to *S. japonicum*. *S. japonicum* egg with the characteristic spine (in center) is surrounded by lymphocytes, mononuclears, fibroblasts and few giant cells. The surrounding lung tissue shows hemorrhage areas.

2. Low-power magnification of infiltration of *S. japonicum* eggs in the appendix, showing numerous *S. japonicum* eggs in the layers of the appendix except in the mucosa, some of which are undergoing resorption and penetration by giant cells. The submucosa is thickened and formed by collagenous tissue.

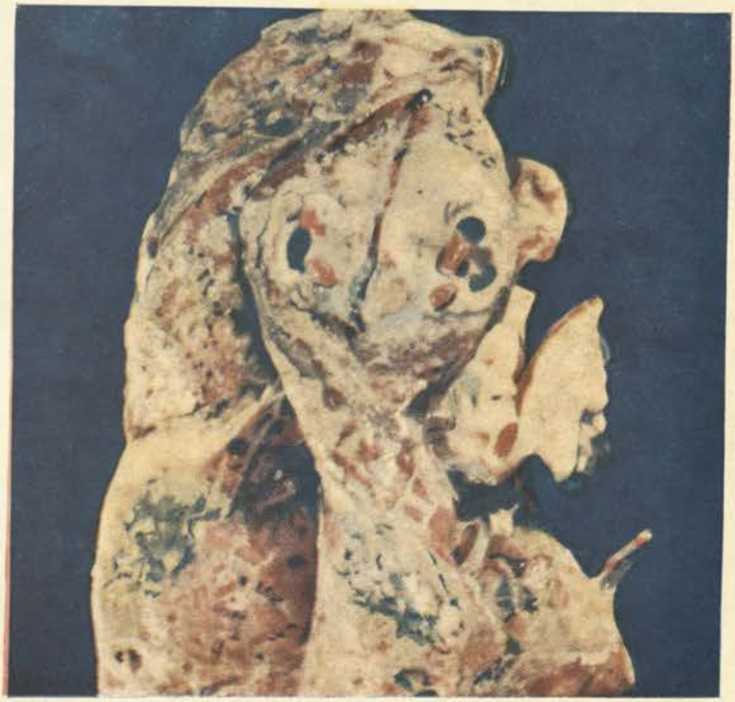
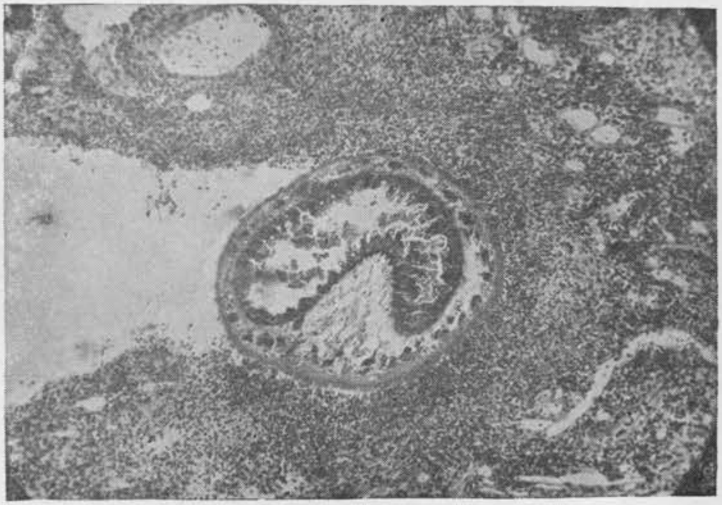


PLATE 1



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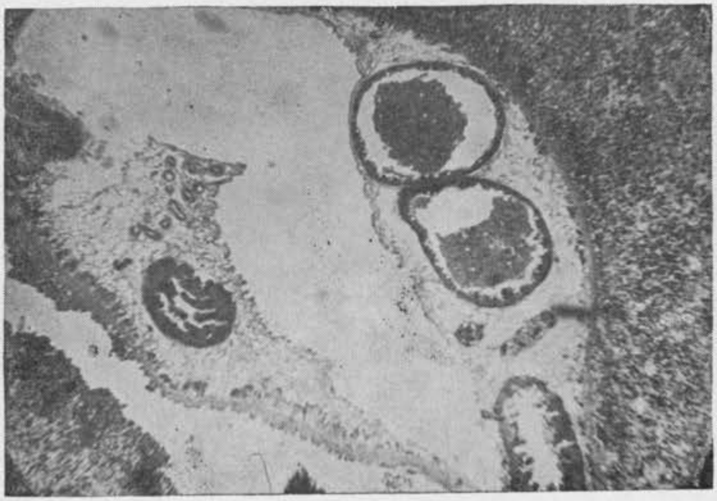

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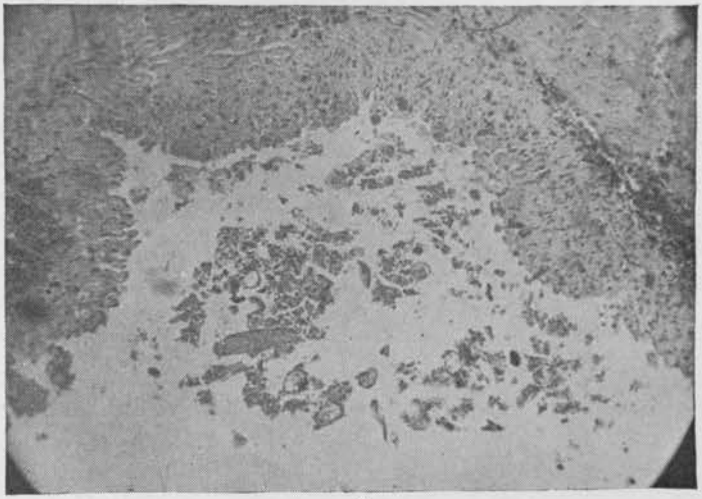
PLATE 2.



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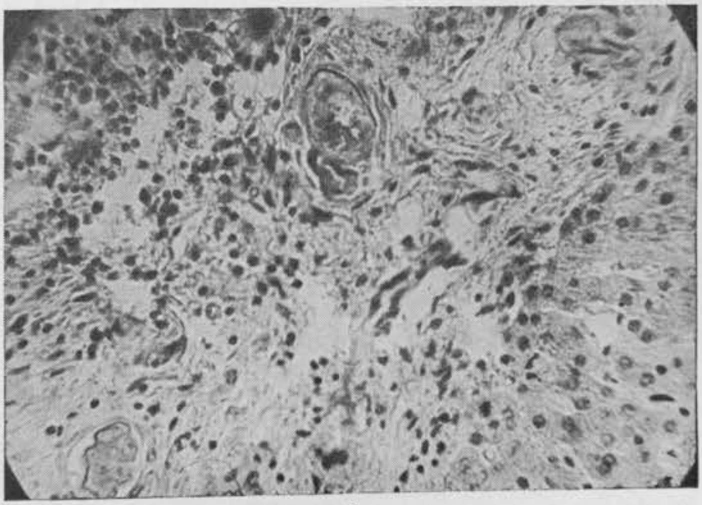

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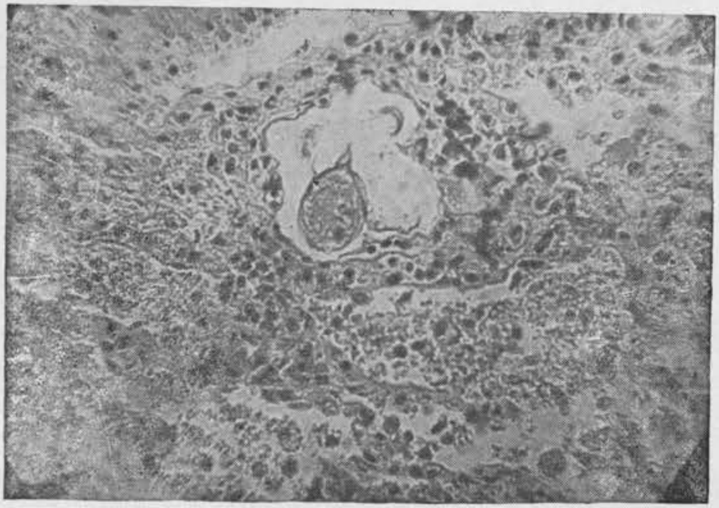
PLATE 3.



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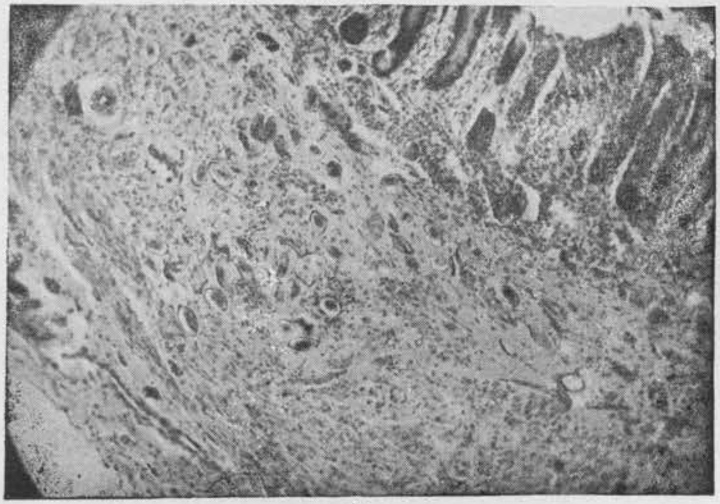

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PLATE 4.

MALARIA CONTROL BY AUTOMATIC FLUSHING OF STREAMS

By Domingo Santiago
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Department of Health, Manila

FIVE TEXT FIGURES

The dramatic success of the sluicing and flushing of streams as an effective control method of malaria vector in the Philippines may be regarded to have its beginning when Russell[1] conducted the initial experiment by using the hand-operated sluice-gate. With the same device, Ejercito[2] undertook his own experiment and obtained the significant reduction of 70 per cent in larval density. Encouraged by the initial success, Ejercito[3] again devised a more elaborate contraption, which he named "Pampana siphon," and repeated his observations. This time the results were more spectacular, the reduction in larval density being from 96 to 99 per cent.

From then on a long list of automatic siphons of different forms and sizes were constructed in different streams in different malarious areas throughout the country where permanent malaria control method was especially indicated. Having repeatedly demonstrated the effectiveness of "Pampana siphon" and other forms of floodgates in small streams, Ejercito and Cellis[4] devised a more permanent concrete automatic siphon in a wider stream in San Pablo City, with emphasis on simplicity and permanence without sacrificing efficiency.

Recognizing the effectiveness and adaptability of such a method to some definite stream conditions in the control of the vector, the Malaria Section of the U.S. Public Health Service, in connection with the Philippine Rehabilitation Act of 1946 passed by the U.S. 79th Congress, constructed several automatic siphons in different provinces where malaria was hyperendemic; and repaired some of those built by the Malaria Division of the Philippine Bureau of Health before the war, which were abandoned or destroyed as a result of said war. The results of these measures were duly reported.

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[1] Philip. Jour. Sci. **47** (1932) 439–447.

[2] Jour. Phil. Med. Assoc. **15** (1935) 177–194.

[3] Riv. di Malariol. **19** (1940) 345–369.

[4] Riv. di Malariol. **20** (1941) 51–65.

The object of this paper is to report the results of three years' observations on the effectiveness of automatic flushing of streams, not only in the reduction of *flavirostris* larval and adult densities, but also in the suppression of malaria transmission in the controlled area.

SELECTION OF OBSERVATION AREAS

Malaria in San Pablo City was the object of intensive and extensive studies and investigations for many years of malaria experts from the Division of Malaria, Department of Health, and other entities. A glance at the map of the City, with its spreading streams and their numerous tributaries, originating from lakes, springs and seepages, would show that it is a typically malarious region. Its luxuriant vegetation and a rather humid atmosphere favor the life and multiplication of the dreaded *A. minimus flavirostris*. Reports compiled from voluminous raw files of the then Malaria Section of the Bureau of Health for the years 1936 to 1940 show that malaria was rampant within the boundaries of the City.

The barrio of San Lucas in San Pablo City was selected as demonstration area, because, aside from being a malarious community, it was very close to the city proper (Fig. 1) The city proper was within the flight range of *A. minimus flavirostris* from any point of the two malariogenic streams traversing the barrio. The control of the vector in this sector would mean the protection of 25,545 inhabitants living in the city and suburbs—representing 50.65 per cent of the total population of the entire City of San Pablo.

Moreover, being a progressive city, there was no gainsaying the fact that the greatest bulk of the inhabitants was concentrated in the urban area. For this reason alone, any effective and permanent malaria control method within the bounds of the city will insure the proper protection of its inhabitants.

On the other hand the barrio of San Antonio, located in the southern periphery of the city, and nine kilometers from the demonstration area, was chosen as the comparison zone, because of its high malaria endemicity, high vector density, and immediate accessibility to the national highway. San Lucas was more thickly populated than San Antonio; but the terrain

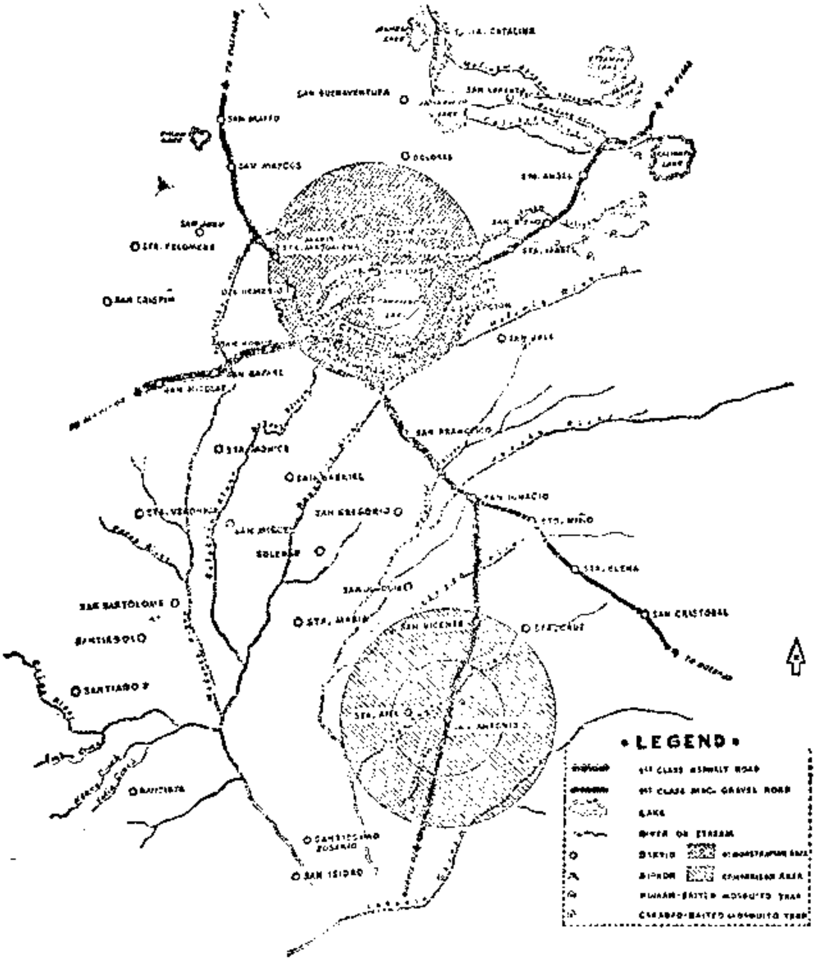

FIG. 1. Sketch map of San Pablo City showing the demonstration and comparison areas; and the location of Automatic Siphons in the barrios of San Lucas, San Pedro, Concepcion, San Jose, Santa Isabel, San Diego, Santo Angel, and San Lorenzo.

of both areas were identical and the living conditions of their inhabitants were practically the same.

Within the demonstration area there were two main breeding streams—Sabang and Malinaw—coursing westward from the east in almost parallel lines. Larval density in the Sabang stream was effectively controlled by an automatic siphon constructed at the outlet of Sampaloc Lake (where no *flavirostris* breeds) at the point where the vector was actually breeding. This siphon was effective as far as 1,073 meters downstream.

Larval density in the Malinaw stream was controlled by a double-dome automatic siphon erected at the eastern periphery and was effective as far as 2,897 meters downstream. World War II and the struggle during the liberation of the Philippines partially destroyed those siphons. The present experiment was conducted after the siphons were repaired and reconditioned.

PROCEDURE

Being a focus of malaria infection as it lay between two malariogenic streams having the highest malaria endemicity among the surrounding barrios, San Lucas was marked as the central point from which a circle of two kilometers' radius was drawn, covering the city proper and five other malarious communities. It was in this circle that definitive and intermediate hosts were subjected to systematic and close malariometric observations for three years—before and at the duration of the experiment.

For an equitable comparison of malariometric data, San Antonio, the comparison area, was taken as the central point from which a similar circle of two kilometers' radius was drawn including thereby two other malarious communities. Similar malariometric observations as those in the demonstration area were conducted simultaneously within this zone for the same period of time.

Two years prior to the flushing of streams, a careful determination of the degree of malaria endemicities in both areas was undertaken. Pre-control spleen and parasite rates were gathered among children 2 to 10 years of age, but particular attention was directed to infants under one year of age. Those periodic surveys were conducted in the same month for two consecutive years. Then the flushing of streams in the demonstration area was started. After one year of uninterrupted flushing operation, intra-control spleen and parasite rates were gathered again among the same age-groups for proper evaluation of results. No less than 50 per cent of the children 2 to 10 years of age and 80 per cent of infants were examined in every yearly survey.

Likewise, entomologic data were gathered simultaneously in both sectors. Six months prior to flushing operation, pre-control observations of larval and adult densities were systematically conducted in streams and harborages. As a supplementary checking of adult density, mosquito trapping with human and carabao baits was also conducted simultaneously in both areas. Those entomologic observations were conducted fortnightly, before and at the duration of the experiment, for twenty-two months.

As side-streams and ground wells in the demonstration area were two other perennial breeding places of *flavirostris*, but not affected by siphonic action, their larval and adult densities were also closely observed. No control measures were applied to those breeding places, to see what adverse effect, if any, the vector originating from those sources might cause.

RESULTS

(*a*) *Definitive host in the demonstration area.*—Twenty-six weeks prior to the flushing of streams the average pre-control larval density of *flavirostris* was 1.4 per dip, but was abruptly reduced to an average intra-control density of 0.002 per dip after two weeks of flushing operation, and remained so at

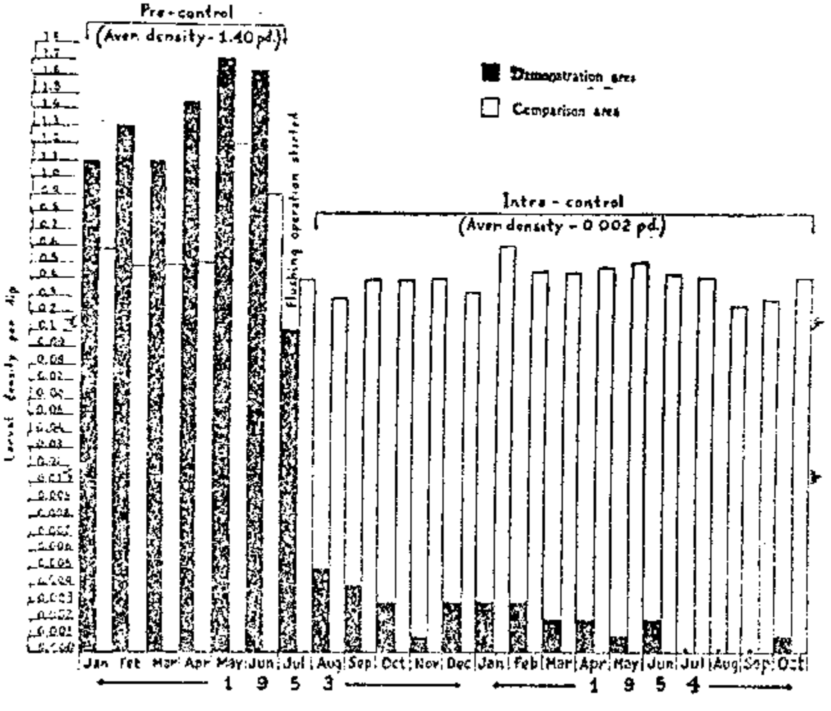

FIG. 2. Comparative average monthly larval densities in streams. Note the drop immediately after the flushing of streams. Average density under brackets refers to demonstration area only.

the duration of another sixty-one weeks' observations. (Table 4 and Fig. 2)

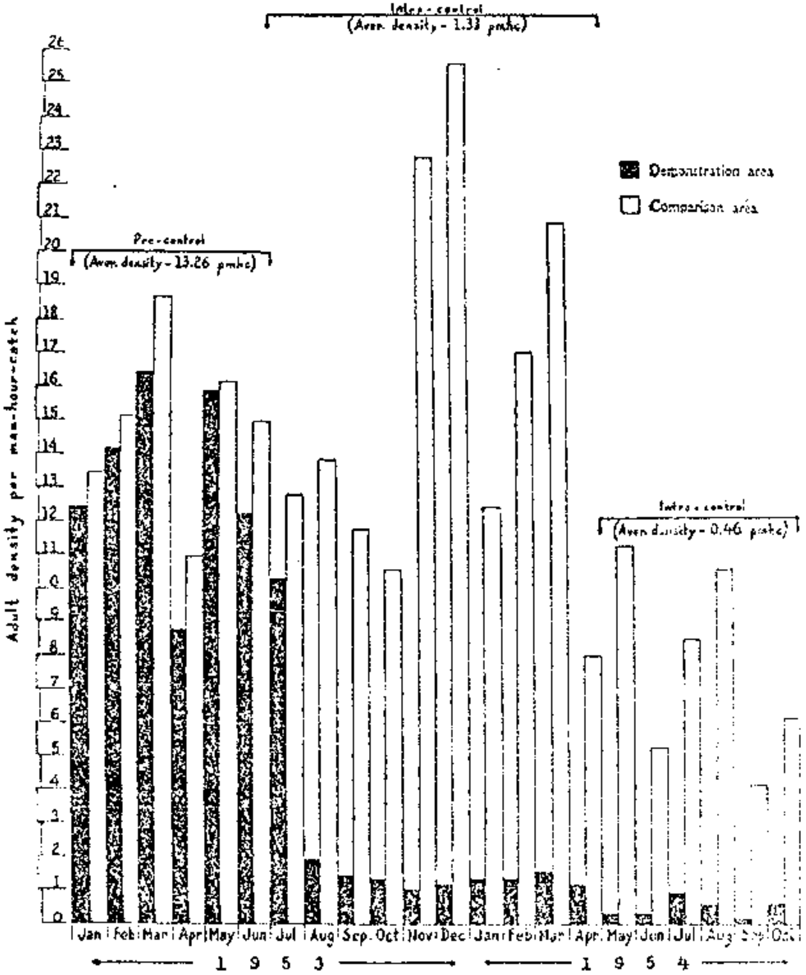

FIG. 3. Comparative average monthly adult densities in harborages. Note the two waves of intra-control average monthly densities showing the gradual reduction of adults. Average density under brackets refers to demonstration area only.

The average pre-control adult density in harborages of this species was 13.26 per man-hour-catching for twenty-six weeks, but was gradually reduced to an average intra-control density of 1.33 per man-hour-catching after four weeks of stream flushing. It took another thiry-nine weeks of prolonged stream flushing before the adult density was brought down further to an irreducible average intra-control density of 0.46 per man-hour-catching, and remained so at the duration of another twenty-six weeks of observations. (Table 4 and Fig. 3)

The average pre-control adult density in the carabao-baited trap was 2.2 per hour-trapping for four weeks, but this was gradually reduced to an average intra-control density of 0.7 per hour-trapping after two weeks of stream flushing. In another two weeks it was further reduced to average intra-control density of 0.12 per hour-trapping and remained so to the end of our observations. (Table 5 and Fig. 4)

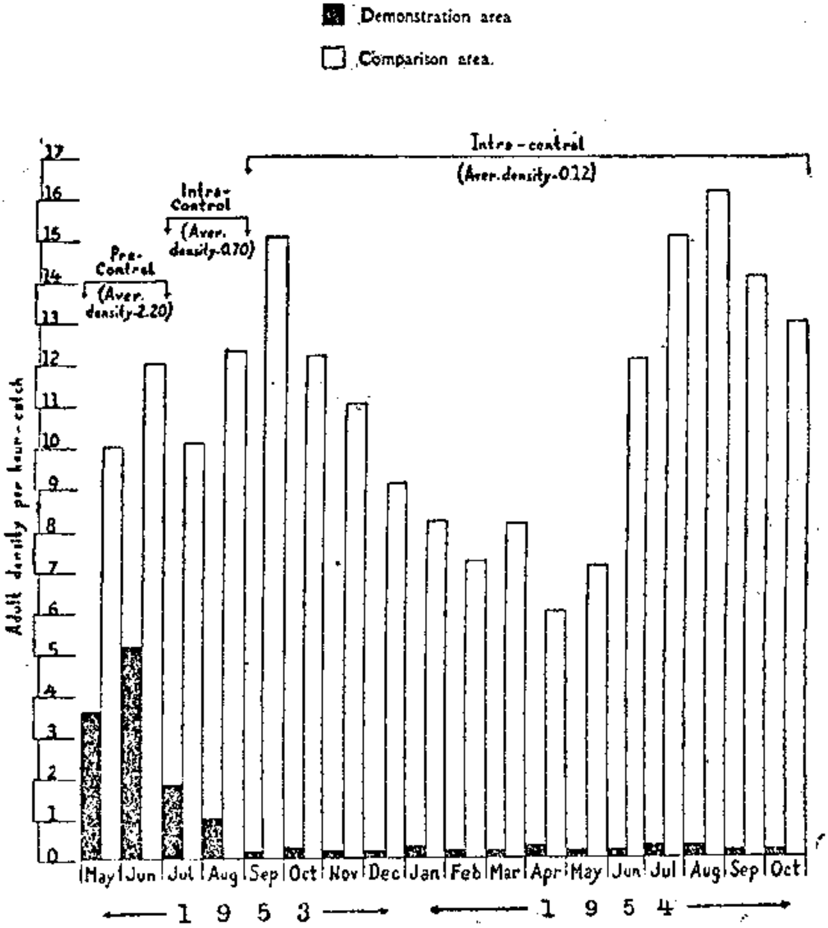

Fig. 4. Comparative average monthly adult densities in carabao-baited traps. Note the two waves of intra-control average monthly densities showing the gradual reduction of adults. Average density under brackets refers to demonstration area only.

The average pre-control adult density in human-baited trap was 0.2 per hour-trapping for four weeks. This was reduced to a steady average intra-control density of 0.02 per hour-trapping after another two weeks of stream flushing. (Table 5 and Fig. 5)

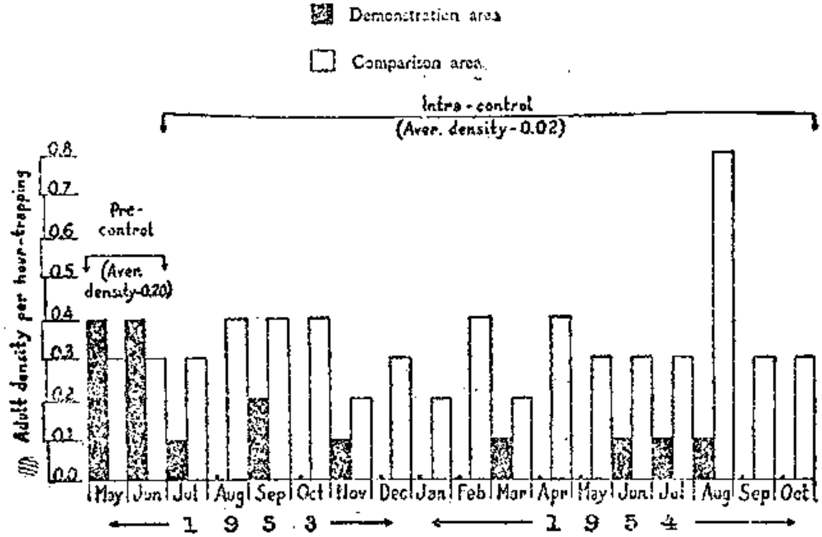

FIG. 5. Comparative average adult densities in human-baited traps. Average density under brackets refers to demonstration area only.

The average pre-control larval density in side-streams and ground wells was 0.05 per dip. It was slightly reduced to an average intra-control density of 0.03 per dip. The average pre-control adult density in harborages in the same environment was 1.5 per man-hour-catching. This was also slightly reduced to an average intra-control density of 0.9 per man-hour-catching at the duration of the experiment.

Inasmuch as this method of control is a continuous operation no post-control data could be considered.

(*b*) *Definitive host in the comparison area.*—The average pre- and intra-control larval and adult densities in all methods of mosquito sampling in the comparison area remained almost the same, with slight variations, in the duration of ninety weeks' observations. (Tables 4 and 5 and Figs. 2–5)

(*c*) *Intermediate host in the demonstration area.* The pre-control spleen rates among children 2 to 10 years of age were 4.49 per cent in 1952 and 4.64 per cent in 1953. These were reduced to intra-control rate of 0.0 per cent in 1954. The pre-control parasite rates among children of the same age group were 4.49 per cent in 1952 and 5.54 per cent in 1953. These were reduced to an intra-control rate of 0.0 per cent in 1954.

TABLE 1.—*Yearly differences in spleen rates (2 to 10 years of age).*

	Number of children	Number examined	Number positives	Positive	±	
	1952 (Pre-control)					
				Per cent		
Demonstration area	892	646	29	4.49	1.2103	
Comparison area	351	216	14	6.48	1.8282	
Difference				1.99	0.9076	(Insignificant)
	1953 (Pre-control)					
Demonstration area	892	560	26	4.64	0.9372	
Comparison area	351	257	26	10.12	0.2550	
Difference				5.48	5.6425	(Significant)
	1954 (Intra-control)					
Demonstration area	892	566	0	0.00	0.2139	
Comparison area	351	280	22	7.86	2.0482	
Difference				7.86	3.8173	(Significant)

TABLE 2.—*Yearly differences in parasite rates (2 to 10 years of age).*

	Number of children	Number examined	Number positives	Positive	±	
	1952 (Pre-control)					
				Per cent		
Demonstration area	892	646	29	4.49	1.2103	
Comparison area	351	210	13	6.19	0.8930	
Difference				1.70	0.2810	(Insignificant)
	1953 (Pre-control)					
Demonstration area	892	560	31	5.54	1.3765	
Comparison area	351	277	11	3.97	0.7018	
Difference				1.57	1.0176	(Insignificant)
	1954 (Intra-control)					
Demonstration area	892	566	0	0.00	0.2137	
Comparison area	351	280	24	8.57	2.1308	
Difference				8.57	4.001	(Significant)

The pre-control inoculation rates among infants under one year of age were 2.38 per cent in 1952 and 2.28 per cent in 1953. These were reduced to an intra-control rate of 0.0 per cent in 1954. (Tables 1, 2, and 3)

TABLE 3.—*Yearly differences in inoculation rates (infants under one year).*

	Number of infants	Number examined	Number positives	Positive	±	
	1952 (Pre-control)					
				Per cent		
Demonstration area	210	168	4	2.38	1.4904	
Comparison area	82	63	2	3.17	3.0245	
Difference				0.79	0.2344	(Insignificant)
	1953 (Pre-control)					
Demonstration area	184	175	4	2.28	0.7084	
Comparison area	60	52	2	3.85	2,7749	
Difference				1.57	0.5482	(Insignificant)
	1954 (Intra-control)					
Demonstration area	258	222	0	0.00	0.3372	
Comparison area	101	83	3	3.61	2.4581	
Difference				3.61	1.4516	(Insignificant)

(*d*) *Intermediate host in the comparison area.*—The spleen rates among children 2 to 10 years of age were 6.48 per cent in 1952; 10.12 per cent in 1953; and 7.86 per cent in 1954. The parasite rates among children of the same age-group were 6.19 per cent in 1952; 3.97 per cent in 1953; and 8.57 per cent in 1954. The inoculation rates among infants under one year were 3.17 per cent in 1952; 3.85 per cent in 1953; and 3.61 per cent in 1954. (Tables 1, 2, and 3)

DISCUSSION

The direct destructive effect of siphonic action on mosquito larvæ in streams abruptly brought down larval density to an average of 0.002 per dip, and was kept at that apparently irreducible level up to the end of our observations. On the other hand, as adult *flavirostris* was only indirectly affected by this method of control, its density reduction was gradual. Four weeks after the control of larvæ in streams 10 per cent of adult *flavirostris* still remained in harborages, as compared

TABLE 4.—*Comparative average monthly larval and adult densities in main streams and harborages by months.*

Date	Larval density per dip (Main streams)		Adult density per man-hour-catching (Main streams harborages)	
	Demonstration area	Comparison area	Demonstration area	Comparison area
January, 1953	1.1	0.58	12.38	13.46
February, 1953	1.31	0.48	14.15	15.12
March, 1953	1.17	0.49	16.33	18.67
April, 1953	1.43	0.51	8.68	10.89
May, 1953	1.73	1.22	15.79	16.98
June, 1953	1.64	0.92	12.22	14.88
FLUSHING OF STREAMS STARTED				
July, 1953	0.12	0.42	10.27	12.72
August, 1953	0.005	0.33	1.86	13.8
September, 1953	0.004	0.42	1.43	11.68
October, 1953	0.003	0.42	1.29	10.48
November, 1953	0.001	0.43	1.0	22.68
December, 1953	0.003	0.34	1.14	25.52
January, 1954	0.003	0.63	1.29	12.36
February, 1954	0.003	0.47	1.29	16.92
March, 1954	0.002	0.46	1.57	20.76
April, 1954	0.002	0.48	1.14	7.92
May, 1954	0.001	0.52	0.29	11.2
June, 1954	0.002	0.45	0.29	5.2
July, 1954	0.0	0.43	0.89	8.4
August, 1954	0.0	0.27	0.57	10.44
September, 1954	0.0	0.31	0.14	4.08
October, 1954	0.001	0.43	0.6	6.1

TABLE 5.—*Comparative average monthly adult densities in human- and carabao-baited traps by months.*[1]

Date	Adult density per hour-trapping (Human-baited trap)		Adult density per hour-trapping (Carabao-baited trap)	
	Demonstration area	Comparison area	Demonstration area	Comparison area
May, 1953	0.4	0.3	3.6	10.0
June, 1953	0.4	0.3	5.2	12.0
FLUSHING OF STREAMS STARTED				
July, 1953	0.1	0.3	1.8	10.1
August, 1953	0.0	0.4	1.0	12.3
September, 1953	0.2	0.4	0.2	15.1
October, 1953	0.0	0.4	0.3	12.2
November, 1953	0.1	0.2	0.2	11.1
December, 1953	0.0	0.3	0.2	9.1
January, 1954	0.0	0.2	0.3	8.2
February, 1954	0.0	0.4	0.2	7.2
March, 1954	0.1	0.2	0.2	8.1
April, 1954	0.0	0.4	0.3	6.0
May, 1954	0.0	0.3	0.2	7.1
June, 1954	0.1	0.3	0.2	12.1
July, 1954	0.1	0.3	0.3	15.1
August, 1954	0.1	0.8	0.3	16.2
September, 1954	0.0	0.3	0.2	14.1
October, 1954	0.0	0.3	0.2	13.0

[1] These observations were conducted rather late on account of delayed construction of traps.

with pre-control density. This percentage persisted for another thirty-nine weeks before it was further reduced to what seemed to be an irreducible minimum of 4 per cent. The same gradual reduction in adult density was noted in the carabao-baited trap. After four weeks of streams flushing, *flavirostris* adult catches were about 30 per cent of those caught before the flushing of streams. In another two weeks the preceding density was further reduced to 10 per cent and remained unchanged for the next sixty-one weeks. In the human-baited trap, adult density was reduced to 10 per cent without further reduction up to the end for our observations.

In side streams and ground wells larval and adult densities were both reduced by 40 per cent. The remaining 60 per cent, which represented 0.03 per dip for larvæ and 0.9 per man-hour-catching for adults, were considered negligible as those were just a little higher than the intra-control larval and adult densities in the controlled main streams.

The reduction of *flavirostris* density would have been more complete had the side-streams and ground wells been eliminated by sanito-agronomic method, as was our previous plan, but our unexpected urgent assignment to another project upset our timetable.

The persistence of the irreducible minimum *flavirostris* larval and adult densities—in spite of the effectiveness of automatic siphonage—seemed to be attributable, in part, to the slightly reduced mosquito density in unflushed side-streams and ground wells. It may also be presumed that the slight reduction of *flavirostris* density in uncontrolled side-streams and ground wells might have been due to fewer eggs laid by fewer adults coming from controlled main streams. Whatever was actually taking place, it was believed that the forced reduction of *flavirostris* density, as affected by flushing of streams entirely suppressed the transmission of malaria in the demonstration area, as evidenced by the disappearance of malaria cases after the institution of this control method.

Pre-control surveys conducted for two consecutive years clearly showed that malaria was endemic in the demonstration as well as in the comparison area, but after one year of stream flushing, significantly all traces of malaria transmission disappeared in the former. That the disappearance of malaria cases in the demonstration area was not due to natural decline nor to the treatment of cases was shown by the fact that in the comparison area, where no malaria control measure whatsoever had been applied, malaria endemicity remained practically unchanged during the experimental period of three years despite the unrestrained treatment of cases therein.

The determination of malaria endemicity in the city proper could not be properly undertaken because most of the city residents refused to submit to blood-taking. However, each time malaria surveys were conducted in the observation areas, inquiries regarding malaria cases were also made in the city proper, specially among physicians. The information gathered therefrom indicated the existence of some malaria cases before the flushing of streams and the disappearance of these cases one year after the control operation was started. Needless to say, such information has no statistical value. The presentation of epidemiologic data in this paper, therefore, has to be limited to those gathered from communities where strict malariometric observations were regularly conducted.

Malaria endemicity in the demonstration area, taken as a whole, would appear comparatively healthy before the experiment was started. But, if the barrio of San Lucas alone—which was the immediate object of control when the siphons were constructed where they are today—would be taken separately, its malaria endemicity would rate as one of the highest among all malarious communities in the whole city of San Pablo. Prior to the flushing of streams, San Lucas was maintaining the following averages: 8.53 per cent spleen rate, 10.06 per cent parasite rate, and 2.49 per cent inoculation rate. This status of faint endemicity tended to rise as indicated by the existing high transmission rate. (Tables 6 and 7)

The prognosis of the impending malaria epidemic in the demonstration area, revealed no sign of malaria transmission of *falciparum* infection and the recession of *vivax* transmission in 1953 as compared with those in 1952. (Table 13)

Moreover, the barrios of San Buenaventura, San Lorenzo, and Santa Catalina, located barely two kilometers north of the demonstration area, revealed no sign of malaria transmission in 1952 and 1953 as shown by our record of malaria surveys conducted therein in those years. But surprisingly enough, in the month of April, 1954, malaria epidemic flared up in the area with the barrio of San Buenaventura bearing the brunt of the heaviest infection as shown by the following percentages: 9.52

per cent spleen rate, 36.07 per cent parasite rate among children 2 to 10 years of age, and 17.86 per cent inoculation rate. This epidemic could have spread in the demonstration area had it not been for the timely control of the vector in this place.

TABLE 6.—*Yearly spleen rates of children (2 to 10 years of age) in the localities in the demonstration area.*

Localities	Population as of 1952	Date	Number of children	Number examined	Number Positives	Positive
						Per cent
Barrio:						
San Lucas	999	November, 1952	238	134	13	9.7
		November, 1953		163	12	7.36
		November, 1954		105	0	0.0
San Pedro	143	November, 1952	40	25	1	4.0
		November, 1953		30	2	6.66
		November, 1954		28	0	0.0
Concepcion	1,153	November, 1952	278	207	7	3.38
		November, 1953		113	4	3.54
		November, 1954		183	0	0.0
Remedio	1,028	September, 1952	229	192	6	3.13
		September, 1953		157	5	3.18
		September, 1954		155	0	0.0
Santa Maria Magdalena	536	October, 1952	107	88	2	2.27
		October, 1953		97	3	3.09
		October, 1954		95	0	0.0
Poblacion	21,686	Epidemiologic data could not be gathered because most of the city residents refused to submit to blood-taking.				

TABLE 7.—*Yearly parasite rates of children (2 to 10 years of age) in the localities in the demonstration area.*

Localities	Population as of 1952	Date	Number of children	Number examined	Number positives	Positive
						Per cent
Barrio:						
San Lucas	999	November, 1952	238	134	13	9.7
		November, 1953		163	17	10.43
		November, 1954		105	0	0.0
San Pedro	143	November, 1952	40	25	1	4.0
		November, 1953		30	2	6.66
		November, 1954		28	0	0.0
Concepcion	1,153	November, 1952	278	207	7	3.38
		November, 1953		113	6	5.31
		November, 1954		183	0	0.0
Remedio	1,028	September, 1952	229	192	6	3.13
		September, 1953		157	2	1.27
		September, 1954		155	0	0.0
Santa Maria Magdalena	536	October, 1952	107	88	2	2.27
		October, 1953		97	4	4.12
		October, 1954		95	0	0.0
Poblacion	21,686	Epidemiologic data could not be gathered because most of the city residents refused to submit to blood-taking.				

The infiltration of adult *flavirostris* into the demonstration area from outside sources was evidently remote or insignificant. That portion of Cabunsod Stream beyond the protected zone but immediately above Malinaw Stream was under control by its own automatic siphon. The downstream extension of Sabang Stream beyond the boundary circle of the demonstration area was rendered unfit for mosquito breeding as it was continually contaminated by refuse oil flowing from a motor pool of a big

TABLE 8.—*Yearly inoculation rates of infants under one year in the localities in the demonstration area.*

Localities	Population as of 1952	Date	Number of infants	Number examined	Number positives	Positive
						Per cent
Barrio:						
San Lucas	999	November, 1952	49	39	1	2.56
		November, 1953	44	43	1	2.33
		November, 1954	69	65	0	0.0
San Pedro	143	November, 1952	12	8	0	0.0
		November, 1953	11	10	0	0.0
		November, 1954	18	15	0	0.0
Concepcion	1,153	November, 1952	49	42	1	2.38
		November, 1953	43	41	1	2.44
		November, 1954	64	55	0	0.0
Del Remedio	1,028	September, 1952	67	53	2	3.77
		September, 1953	51	48	1	2.08
		September, 1954	69	55	0	0.0
Santa Maria Magdalena	536	October, 1952	33	26	0	0.0
		October, 1953	35	33	1	3.03
		October, 1954	38	32	0	0.0
Poblacion	21,686	Epidemiologic data could not be gathered because most of the city residents refused to submit to blood-taking.				

TABLE 9.—*Yearly spleen rates of children (2 to 10 years of age) in the localities in the comparison area.*

Localities	Population as of 1952	Date	Number of children	Number examined	Number positives	Positive
						Per cent
Barrio:						
San Antonio	866	October, 1952	188	106	6	5.66
		October, 1953	--------	118	12	10.17
		October, 1954	--------	127	10	7.87
San Vicente	246	October, 1952	75	60	4	6.66
		October, 1953	--------	73	7	9.59
		October, 1954	--------	74	6	8.11
Santa Ana	403	October, 1952	88	50	4	8.0
		October, 1953	--------	66	7	10.6
		October, 1954	--------	79	6	7.59

land transportation company closely located to that stream. The upper part of Pataynatubig Stream, running across the northern side of the demonstration area, was only a discharge canal during the rainy season, drying up immediately after every downpour. Banadero River in the southern part was efficiently controlled by the malaria control project financed and operated by Mr. W. P. Schetilig, a San Pablo industrialist.

Those concerted controlling circumstances operating in our favor readily prevented flight infiltration of the vector species from the surrounding areas. If by chance some lucky adults succeeded in breaking through our outside line of defense, such mosquitoes must have come from great distances carried by wind; their progenies (in the aquatic stages) will certainly be exterminated by siphonic action in streams.

TABLE 10.—*Yearly parasite rates of children (2 to 10 years of age) in the localities in the comparison area.*

Localities	Population as of 1952	Date	Number of children	Number examined	Number positives	Positive
Barrio:						*Per cent*
San Antonio	866	October, 1952	188	102	6	5.88
		October, 1953		144	5	3.46
		October, 1954		127	11	8.66
San Vicente	246	October, 1952	75	59	4	6.78
		October, 1953		70	4	5.71
		October, 1954		74	6	8.11
Santa Ana	433	October, 1952	88	49	3	6.12
		October, 1953		63	2	3.17
		October, 1954		79	7	8.8

TABLE 11.—*Yearly inoculation rates of infants under one year of age in the localities in the comparison area.*

Localities	Population as of 1952	Date	Number of infants	Number examined	Number positives	Positive
Barrio:						*Per cent*
San Antonio	866	October, 1952	41	33	1	3.03
		October, 1953	44	40	2	5.0
		October, 1954	66	54	2	3.7
San Vicente	246	October, 1952	27	21	1	4.76
		October, 1953	4	4	0	0.0
		October, 1954	8	6	0	0.0
Santa Ana	433	Octoger, 1952	14	9	0	0.0
		October, 1953	12	8	0	0.0
		October, 1954	27	23	1	4.35

As the two siphons used in this experiment were constructed long before the outbreak of World War II, their cost could not be definitely ascertained, hence it is not given in this report. The estimated cost of operation and maintenance was ₱200.00 per year. This estimate was based on the time spent for the two siphons by a laborer, who made regular daily visits to seventeen other siphons operating in other malarious places within the city of San Pablo. For a population of 25,545 inhabitants directly protected from malaria by the two siphons, the per capita cost per year for operation and maintenance was ₱0.008.

TABLE 12.—*Malariometric observations (Pre- and intra-control entomologic and epidemiologic data).*

	Demonstration area	Comparison area
I. ENTOMOLOGIC DATA		
Definitive host		
A. minimus flavirostris		
1. Average larval density:		
Pre-control, pd 1953	1.40	0.7
Intra-control, pd 1954	0.002	0.5
2. Average adult densities:		
In harborages—		
Pre-control, pmhc 1953	13.26	14.85
Intra-control, pmhc 1954	0.46	12.5
In carabao-baited traps—		
Pre-control, pht 1953	2.2	5.5
Intra-control, pht 1954	0.12	5.52
In human-baited traps—		
Pre-control, pht 1953	0.2	0.15
Intra-control, pht 1954	0.02	0.17
Unflushed sidestreams and wells (Demonstration area only)		
3. Average larval density:		
Pre-control, pd 1953	0.05	----------
Intra-control, pd 1954	0.03	----------
4. Average adult density:		
In harborages—		
Pre-control, pmhc 1953	1.5	----------
Intra-control, pmhc 1954	0.9	----------
II. EPIDEMIOLOGIC DATA		
Intermediate host		
5. Splenomegaly		
Average spleen rates		
Children 2 to 10 years:		
Pre-control, per cent 1952	4.49	6.48
Pre-control, per cent 1953	4.64	10.12
Intra-control, per cent 1954	0.00	7.86
6. Incidence of parasites		
Average parasite rates		
Children 2 to 10 years:		
Pre-control, per cent 1952	4.49	6.19
Pre-control, per cent 1953	5.54	3.97
Intra-control, per cent 1954	0.00	8.57
Average inoculation rates		
Infants under one year:		
Pre-control, per cent 1952	2.38	3.17
Pre-control, per cent 1953	2.28	3.85
Intra-control, per cent 1954	0.0	3.61

Abbreviation: *pd*, per dip; *pmhc*, per man-hour-catching; *pht*, per hour-trapping.

NOTE: The delay in the collection of entomologic data for one year was due to insufficiency of personnel, repair of automatic siphons, construction of mosquito traps, and fixing of larval and adult observation posts in streams and harborages.

TABLE 13.—*Yearly plasmodia prevalence and their stages; and spleen enlargement in the demonstration area.*

1952					1953					1954				
Infants under one year		Children 2 to 10 years			Infants under one year		Children 2 to 10 years			Infants under one year		Children 2 to 10 years		
Parasite		Parasite		Spleen	Parasite		Parasite		Spleen	Parasite		Parasite		Spleen
Plasmodium	Stages	Plasmodium	Stages		Plasmodium	Stages	Plasmodium	Stages		Plasmodium	Stages	Plasmodium	Stages	
falc.	t- -	falc.	t- -g	----	falc.	t- -	falc.	t- -g	----	----	----	----	----	----
----	----	vivax	t-s-g	----	----	----	vivax	t- -g	----	----	----	----	----	----
----	----	----	----	2	----	----	falc.	t- -	1	----	----	----	----	----
----	----	falc.	- -g	2	----	----	vivax	t-s-g	----	----	----	----	----	----
----	----	----	----	1	----	----	falc.	t- -g	----	----	----	----	----	----
----	----	vivax	t- -g	1	----	----	vivax	t- -g	----	----	----	----	----	----
----	----	vivax	t-s-g	----	----	----	----	----	2	----	----	----	----	----
----	----	vivax	t- -g	2	----	----	falc.	t- -	1	----	----	----	----	----
----	----	vivax	t- -g	2	----	----	----	----	1	----	----	----	----	----
----	----	falc.	- -g	2	----	----	falc.	t- -	----	----	----	----	----	----
----	----	vivax	t- -g	2	----	----	falc.	t- -g	----	----	----	----	----	----
----	----	falc.	t- -g	2	----	----	----	----	3	----	----	----	----	----
----	----	vivax	t- -g	2	----	----	----	----	2	----	----	----	----	----
----	----	vivax	t- -g	3	----	----	vivax	t- -g	----	----	----	----	----	----
----	----	falc.	t- -g	----	----	----	----	----	2	----	----	----	----	----
----	----	----	t-s-g	3	----	----	falc.	t- -	1	----	----	----	----	----
----	----	----	t-s-g	1	----	----	falc.	t- -g	----	----	----	----	----	----
----	----	vivax	t- -g	1	----	----	vivax	t-s-g	----	----	----	----	----	----
vivax	t- -g	vivax	----	1	----	----	----	----	2	----	----	----	----	----
----	----	vivax	----	----	----	----	falc.	t- -	1	----	----	----	----	----
----	----	falc.	t-s-g	----	----	----	falc.	t- -g	----	----	----	----	----	----
----	----	falc.	t-s-g	1	----	----	falc.	t- -	1	----	----	----	----	----
----	----	falc.	t- -g	----	----	----	falc.	t- -	2	----	----	----	----	----
----	----	vivax	t-s-g	----	----	----	vivax	-s-g	----	----	----	----	----	----
----	----	falc.	t- -	1	----	----	----	----	1	----	----	----	----	----
----	----	----	----	2	----	----	vivax	t-s-g	----	----	----	----	----	----
----	----	----	----	2	----	----	----	----	2	----	----	----	----	----
----	----	----	----	1	falc.	t- -	----	----	3	----	----	----	----	----
----	----	----	----	3	----	----	----	----	2	----	----	----	----	----
falc.	t- -	vivax	t- -	1	falc.	t- -	falc.	t- -	----	----	----	----	----	----
falc.	t- -	falc.	t- -	----	----	----	vivax	t- -g	----	----	----	----	----	----
----	----	vivax	t-s-g	----	----	----	falc.	t- -	1	----	----	----	----	----
----	----	falc.	t- -g	1	----	----	vivax	t-s-g	----	----	----	----	----	----
----	----	vivax	t- -g	1	----	----	falc.	t- -	----	----	----	----	----	----
----	----	vivax	t-s-g	----	----	----	falc.	t- -g	----	----	----	----	----	----
----	----	----	----	3	----	----	----	----	1	----	----	----	----	----

----------	----------	----------	----------	2	falc.	- -g	falc.	t- -g	1	----------	----------	----------	----------	----------
----------	----------	falc.	t- -	2	----------	----------	falc.	t- -g	2	----------	----------	----------	----------	----------
----------	----------	vivax	t-s-g	1	----------	----------	----------	----------	2	----------	----------	----------	----------	----------
----------	----------	----------	----------	2	----------	----------	----------	----------	3	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	----------	----------	1	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	vivax	t- -	vivax	t- -g		----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	falc.	t- -	1	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	falc.	t- -	1	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	vivax	t-s-g		----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	----------	----------	2	----------	----------	----------	----------	----------
f- 3 v- 1	t- 4 g- 1	f-12 v-17	t- 27 s- 8 g-23	1-12 2-13 3- 4	f- 3 v- 1	t- 3 g- 1	f-20 v-11	t-30 s- 6 g-19	1-13 2-10 3- 3	----------	----------	----------	----------	----------
4	----------	29	----------	29	4	----------	31	----------	26	----------	----------	----------	----------	----------

t, trophozoite; s, schizont; g, gametocyte.

TABLE 14.—*Yearly plasmodia prevalence and their stages; and spleen enlargement in the comparison area.*

1952					1953					1954				
Infants under one year		Children 2 to 10 years			Infants under one year		Children 2 to 10 years			Infants under one year		Children 2 to 10 years		
Parasite		Parasite		Spleen	Parasite		Parasite		Spleen	Parasite		Parasite		Spleen
Plasmodium	Stages	Plasmodium	Stages		Plasmodium	Stages	Plasmodium	Stages		Plasmodium	Stages	Plasmodium	Stages	
falc.	t- -	falc.	- -g	--------	vivax	t- -	--------	--------	2	falc.	t- -	falc.	- -g	2
--------	--------	vivax	- -g	1	falc.	t- -	--------	--------	2	falc.	t- -	--------	--------	2
--------	--------	vivax	t- -g	--------	--------	--------	vivax	t- -	--------	--------	--------	--------	--------	2
--------	--------	vivax	t-s-g	--------	--------	--------	falc.	t- -	--------	--------	--------	falc.	t- -g	2
--------	--------	falc.	t- -g	1	--------	--------	--------	--------	3	--------	--------	vivax	t-s-g	2
--------	--------	falc.	t- -	1	--------	--------	--------	--------	2	--------	--------	falc.	- -g	--------
--------	--------	--------	--------	2	--------	--------	--------	--------	2	--------	--------	vivax	- -g	--------
--------	--------	--------	--------	2	--------	--------	vivax	- -g	--------	--------	--------	falc.	t- -	--------
--------	--------	--------	--------	1	--------	--------	vivax	t- -g	3	--------	--------	falc.	- -g	3
vivax	t- -	--------	--------	2	--------	--------	--------	--------	2	--------	--------	--------	--------	2
--------	--------	falc.	t- -	1	--------	--------	vivax	-s-g	2	--------	--------	--------	--------	3
--------	--------	--------	--------	3	--------	--------	--------	--------	2	--------	--------	vivax	-s-g	--------
--------	--------	vivax	- -g	--------	--------	--------	--------	--------	1	--------	--------	--------	--------	1
--------	--------	--------	--------	2	--------	--------	--------	--------	2	--------	--------	--------	--------	1
--------	--------	vivax	t-s-g	--------	--------	--------	--------	--------	1	--------	--------	vivax	t- -g	--------
--------	--------	vivax	t- -g	--------	--------	--------	vivax	t-s-	2	--------	--------	falc.	t- -g	--------
--------	--------	--------	--------	2	--------	--------	vivax	-s-g	--------	--------	--------	vivax	t-s-g	--------
--------	--------	vivax	t-s-g	--------	--------	--------	--------	--------	2	--------	--------	vivax	t-s-g	1
--------	--------	--------	--------	3	--------	--------	--------	--------	1	--------	--------	--------	--------	2
--------	--------	--------	--------	3	--------	--------	falc.	t- -	--------	--------	--------	vivax	t- -	--------
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									1	fale.	t- –			2
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												vivax	t-s-g	
												fale.	t- –	
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f- 1 v- 1	t- 2 s- 0 g- 0	f- 5 v- 8	t-10 s-3 g-10	1- 6 2- 5 3- 3	f- 1 v- 1	t- 2 s- 0 g- 0	f- 3 v- 8	t- 7 s- 5 g- 6	1- 7 2-15 3- 4	f- 3 v- 0	t- 3 s- 0 g- 0	f-10 v-14	t-19 s- 6 g-15	1- 8 2-11 3- 3
2		13		14	2		11		26	3		24		22

SUMMARY AND CONCLUSION

1. The automatic flushing of streams was found effective not only in the reduction of *flavirostris* larval and adult densities but also, and much more importantly, in the suppression of malaria transmission in the controlled area.

2. The direct destructive effect of siphonic action on mosquitoes breeding in streams abruptly brought down larval density to the minimum, while the reduction of adult density was gradual.

3. Larval and adult densities in unflushed side-streams and ground wells were reduced by 40 per cent only.

4. The persistence of the irreducible minimum *flavirostris* larval and adult densities in the controlled main streams seemed to be partly attributable to the slightly reduced mosquito density in side-streams and ground wells. However, the reduction of *flavirostris* density as affected by the flushing of streams completely suppressed malaria transmission, as evidenced by the disappearance of malaria cases in the demonstration area.

5. That the disappearance of malaria cases in the demonstration area was not due to natural decline nor to the treatment of cases was shown by the fact that in the comparison area where no control measure had been applied, malaria endemicity remained unchanged despite the unrestrained treatment of cases.

6. Endemicity in the demonstration area, though faint prior to the experiment tended to rise as indicated by the then existing high transmission rate; and the exacerbation of *falciparum* infection was accompanied by a recession in *vivax* transmission.

7. The malaria epidemic in San Buenaventura sector could have easily spread southward had it not been for the timely control of the vector species in the demonstration area; or had there been infiltration of adult *flavirostris* from the epidemic area into the protected zone.

8. The estimated cost of maintenance and operation of the two automatic siphons used in this experiment was ₱200.00, or about ₱0.008 per capita per year.

The effectiveness of stream flushing in reducing larval density of *flavirostris* in the Philippines has been demonstrated time and again. Our experiment was carried out, not because we were still in doubt as to its destructive effect on larval density, but because we needed more data which would show that the forced reduction of vector density would necessarily be followed by forced reduction of malaria incidence. The demonstration could be repeated and the malariometric observations could be extended for any number of years, but the results would remain practically the same.

ACKNOWLEDGMENT

The author is greatly indebted to the late Dr. Antonio Ejercito, director of the Malaria Eradication Project, for his interest in pushing through the San Pablo City experiment; to Mr. Francisco E. Baisas, associate malariologist, for his constructive suggestions; and to the personnel of the malaria extension unit in San Pablo City for their co-operation in the task of gathering data and conducting varied and long field observations.

A STUDY OF THE GAMMA-RAY SHIELDING PROPERTIES OF SOME PHILIPPINE MATERIALS

By JOSE O. JULIANO, RAMON DE LA PEÑA, and LETICIA BONOAN
Philippine Atomic Energy Commission, Manila

FIVE TEXT FIGURES

INTRODUCTION

Gamma rays are considered as one of the more difficult types of radiation to attenuate because of the so-called "one-shot" nature of their absorption in matter. Theoretically, an infinite barrier or absorber would be necessary to completely stop all gamma rays. This of course is not practicable and what is usually done is to interpose between the source of radiation and the area to be protected enough absorbers so that the gamma-ray intensity reaching the protected region is within the permitted safe level. In order to determine the thickness of the absorber that should be used to give the desired results the linear absorption coefficient, the half-value thickness or the mass absorption coefficient of the absorber for the gamma-ray energy being absorbed should be known. In other countries, tables are available listing these values for their various building construction-materials as a function of the energy of the gamma ray. Hence by simple calculations based on these tables the desired thickness can easily be calculated. In the Philippines we have truly native materials which have not been studied. The present studies is to determine their gamma-ray absorption characteristics to serve as ready reference for safety engineers and health physicists.

It would be much better if the absorption characteristics like the half-value thickness would be determined for each type of material using different gamma-ray energies; but, due to the inadequacy of available radioactive sources at the moment this study was confined to the 662-kev gamma ray of Cs^{137}. It is hoped that in the future similar studies using higher and lower gamma-ray energies would be done to complete these absorption curves for different photon energies. However for the moment the values obtained in this work would suffice and a reasonable degree of accuracy by correlation can be used to determine μ and $X_{\frac{1}{2}}$ for photon energies different from 662 kev.

PROCEDURE

A 2-mc Cs^{137} sample[1] was used as the source of the 662-kev gamma ray. The beta particles, conversion electrons and x-rays associated with the decay of Cs^{137} were eliminated from the beam by placing a 272 mg/cm^2 aluminum absorber which is enough to stop even 700-kev electrons. The useful gamma beam was collimated by steel and lead bricks and a Geiger-Müller tube with its electronic accessories was used to measure the amount of transmitted beam. In between the source and the detector were placed the materials whose absorption coefficients were to be determined as shown in Fig. 1.

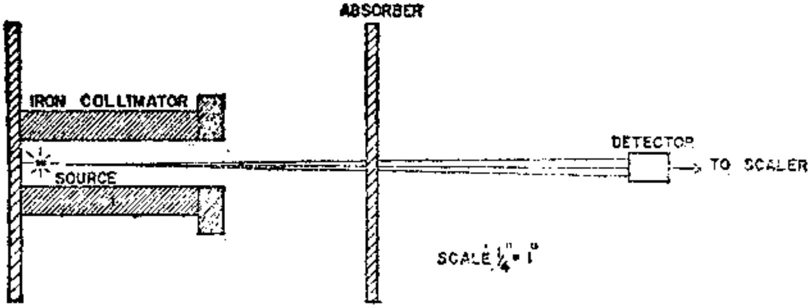

FIG. 1. Experimental arrangement used for the absorption measurements.

Due to the large distance of the detector from the absorber no collimators were used about the Geiger tube. The reliability and accuracy of the set-up was checked in each run by comparing the experimentally obtained half-value thicknesses of Pb and Al with that reported for 662-kev gamma rays. In all cases the experimental results agreed with the accepted values for Pb and Al and hence it can be assumed that the determined values for the other samples were correct.[2]

The linear absorption coefficients μ expressed in cm^{-1} and the half-value thickness $X_{\frac{1}{2}}$ in cm were determined and calculated

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[1] Obtained from the Radiochemical Centre, Amersham, Buckinghamshire, England, as a solid encased in a stainless steel shell and made available through the courtesy of Mr. Hans Rothkirk, Franklin Baker Co. of the Philippines.

[2] White, G. R. National Bureau of Standards Report No. 1003 (1952).

TABLE 1.—*The linear absorption coefficients and half-value thicknesses of some Philippine building materials for 662-kev gamma rays.*

	u (cm^{-1})	X ½ (cm)
Rattan (*Calamus* sp.)	0.026	27.1
Bagasse acoustic-boards	0.030	23.0
Red lauan (*Shorea negrosensis* Foxw.)	0.036	19.5
Tañgile "Filipinas" plywood	0.038	18.3
"Sawali"	0.043	16.2
"Nipa" shingles	0.044	15.6
Dao (*Dracontomelum dao* Merr. & Rlofe)	0.047	14.7
Apitong (*Dipteracarpus grandiflorus* Blco.)	0.052	13.3
Tañgile (*Shorea polysperma* Merr.)	0.054	13.0
Adobe	0.055	12.7
Narra (*Pterocarpus indicus* Willd.)	0.056	12.4
Bamboo (*Bambusa spinosa*)	0.061	11.1
"Lawanit" Pressed-board	0.063	11.1
"Permanent" concrete hollow blocks	0.066	10.5
"Asbestos" wall board	0.067	10.4
"Permanent" filled-in concrete hollow-blocks	0.073	9.5
Coconut husk pressed-board	0.075	9.3
Yakal (*Hopea basilanica* Foxw.)	0.077	9.0
Bataan magnetite sand	0.117	5.9
Asbestos pressed-board	0.120	5.8
"Custom-built" firebricks	0.123	5.6
Plastic (from agricultural wastes)	0.124	5.6
Japanese glazed tiles	0.128	5.4
"Corona" glazed tiles	0.141	4.9
Aluminum	0.168	4.1
"Fil-Hispano" vitrified floor tile	0.208	3.3
"Capiz" shells (*Placuna placenta* Linn.)	0.218	3.2
"Apo" galvanized iron	0.301	2.3
Lead	0.635	1.1

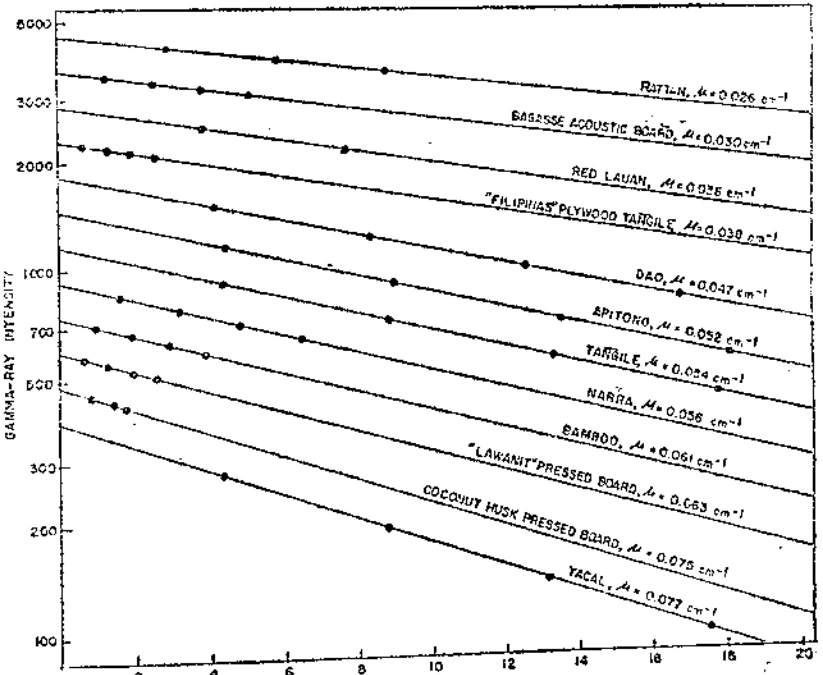

FIG. 2*a*. Absorption curves of various Philippine building materials for Cs^{137} 662-kev photon.

respectively from the plot of the logarithm of the intensity of the transmitted beam as a function of the absorber thickness. The slope of the resulting straight line was used in expressing the μ of the samples studied in this report.

The native building materials used in this study were the following: Bataan magnetite sand,[3] "Apo" galvanized-iron sheets, "Custom-built" firebricks, "Permanent" concrete hollow-blocks, "Corona" glazed-tiles, "Fil-Hispano" vitrified floor-tiles, "Lawanit" pressed boards, sugarcane bagasse acoustical board, "Eternit" asbestos pressed-boards, "Filipinas" plywood (tañgile), sawali sheets (from the inner bamboo struc-

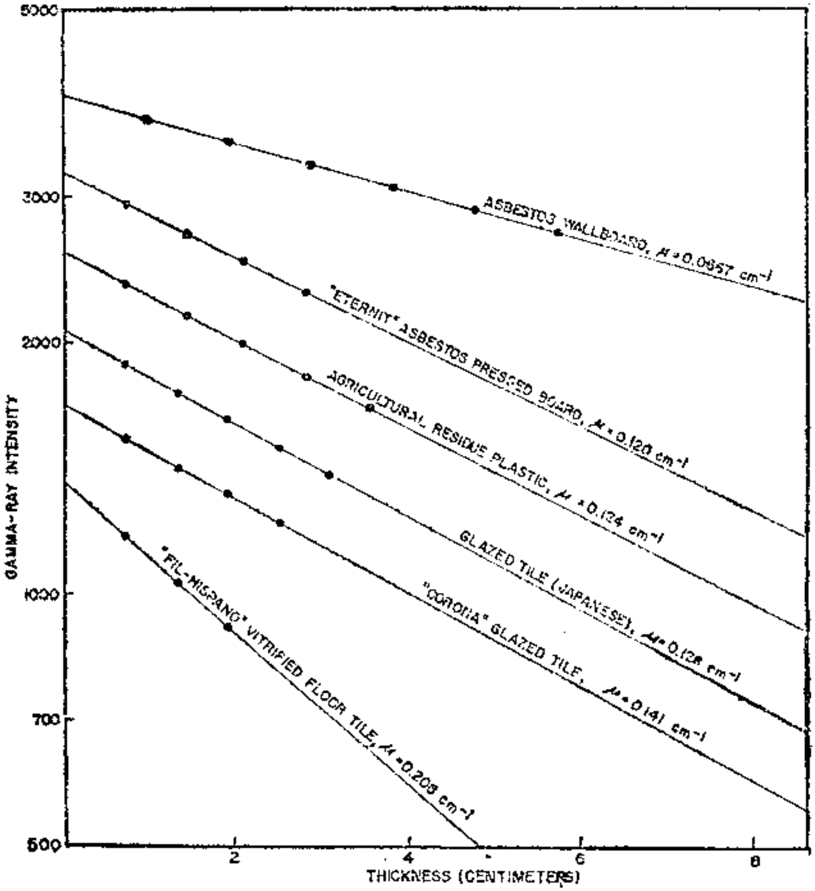

FIG. 26. Absorption curves of various Philippine building materials for the Cs ^{137} 662-kev photon.

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[3] Analysis: Moisture, 0.26 per cent; density of the sample, 4.03 gm/cc; density of iron seperate, 4.8 gm/cc; density of sand separate, 2.97 gm/cc.

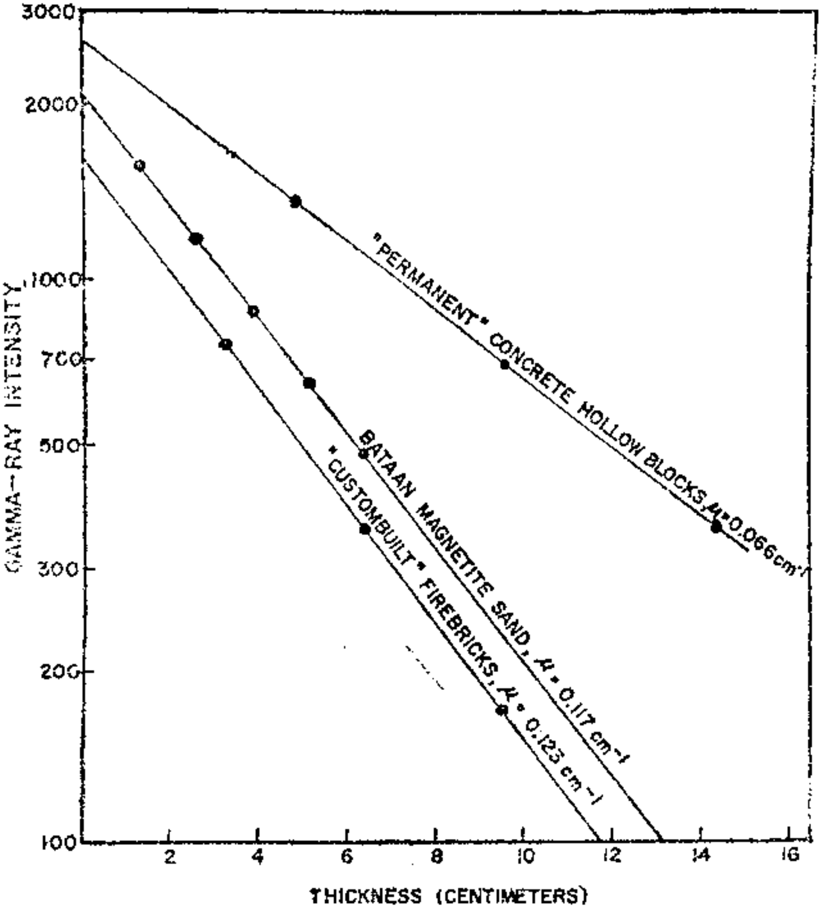

FIG. 2c. Absorption curves of various Philippine building materals for Cs ^{137} 662-kev photon.

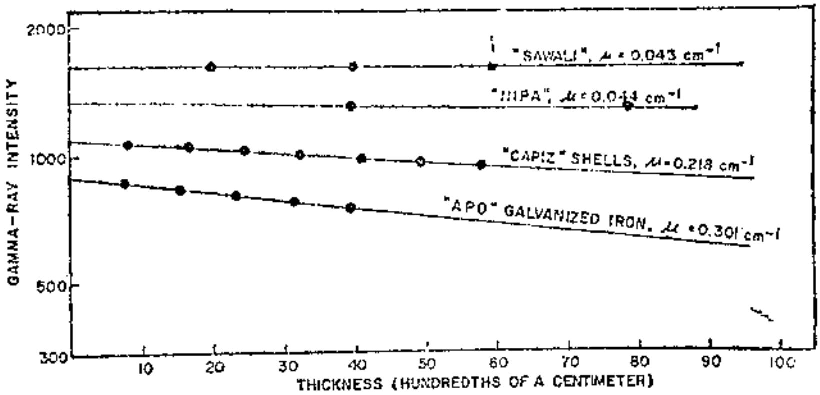

FIG. 2d. Absorpton curves of various Philippine building materials for Cs ^{137} 662-kev photon.

ture), rattan, bamboo, nipa shingles, "Capiz" shells, apitong, narra, dao, yakal, red lauan, tañgile and an agricultural-residue plastic.[4] In addition a Japanese glazed tile, aluminum, and lead were studied as a check on the accuracy of the results obtained.

RESULTS AND DISCUSSION

The results are plotted (Figs. 2*a*, 2*b*, 2*c*, and 2*d*) and summarized in Table 1. It must be remembered that the results given are normalized to the absorbing efficiency of the samples per unit thickness. The samples as listed in Table 1 are arranged in the order of increasing absorption coefficients or decreasing half-thicknesses. Explanations for the results are not discussed in this report; however, a few comments are given.

1. Bamboo as a solid piece of material is considerably better than rattan as a shielding material. This is expected for rattan is more porous than bamboo. It would be interesting to compare the absorption coefficients of bamboos of different degrees of maturity.

2. Narra and yakal, the known hard woods compare well with our adobe stones in stopping 662-kev photons.

3. Coconut husk pressed-boards are almost as dense as our hard woods yakal and narra. This may indicate its bright future as a building material.

4. It is quite striking for the plastic from agricultural wastes to have a μ almost as large as glazed titles, asbestos pressed-boards, and magnetite sand.

5. A shielding material which may be of importance would be powdered or crushed shells of "Capiz" because of its high μ. Other sea shells abundant in the Philippines can be investigated.

6. A commercial method of measuring the gauge number of galvanized iron sheets may be developed by determining their μ values.

7. From the μ values of our Philippine-made tiles it can be said that their density and compactness compare well with the imported Japanese-made tile.

ACKNOWLEDGMENTS

The authors take this opportunity in expressing their gratitude to Dr. J. Banzon and Commissioner F. A. Medina for their continuous interest and help during the undertaking of this project.

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[4] From a plastic-molding powder produced from copra meal and other agricultural residues; furnished by Mrs. M. A. Templa of the National Institute of Science and Technology, Manila.

NOTE ON A MICRONESIAN SPECIES OF FREYCINETIA (PANDANACEÆ)

PACIFIC PLANT STUDIES, XVII

By Harold St. John
Bishop Museum, Honolulu

FREYCINETIA VILLALOBOSII Martelli, emend. St. John.

F. Villalobosensis Martelli ex Kanehira, Bot. Mag. (Tokyo) 48 (1934) 128–129.

This species was published in 1934 as *F. Villalobosensis,* and was accepted unchanged by Kanehira in 1935 in his Enumeration of Micronesian Plants. The holotype was collected in Babeldaob Island, Palau Islands, by Ladermann. Several recent collections have been examined. Martelli stated: "I name this plant in honor of the Spanish navigator Arrecipes Ruy de Villalobos who discovered the groups of the Islands in 1534 and died at Amboina." In forming the specific epithet he gave it an adjectival place ending. There seems to be no part of the Palau Islands that bear the name of the discoverer, de Villalobos. The only place having the name Villalobos is a town in northwest Spain. Certainly this tropical liana is not a denizen of Spain. Since Martelli clearly stated that he was naming his new species for the man, his use of the place suffix *-ensis* was an obvious error. Here, the epithet is corrected to read: *Freycinetia Villalobosii,* by the provisions of article 73, International Code of Botanical Nomenclature, Paris ed., 1956.

BOOK REVIEWS

Books reviewed in this section represent a selection from those received from time to time by the National Institute of Science and Technology and the Philippine Atomic Energy Commission, two sister agencies under the National Science Development Board.

Guide to the Literature of Mathematics and Physics. By N.G. Parke III. 2nd. Rev. Ed. New York, Dover Publications, Inc., 1958. 454 pp. Paperbound. Price, $2.49.

This is a collection of titles intended to make available to researchers the sources of reference materials on mathematics, physics, and engineering science. Unlike the first edition which first appeared in 1947, this revised edition has doubled its entries, reaching more than 5,000 and including books in English, French, German, and Russian published up to 1956.

Part I, which deals with "General Considerations," introduces the beginner to book research work with discussions on the types of references, the sources of information, the effective methods of study and note-taking, and the tests for accomplishment.

The author observes that readers fall into two classes: those who read a few books thoroughly and those who read many books comparatively. Reading a few books thoroughly "gives one a single, coordinate picture of the subject," while reading many books comparatively gives one "an integrated picture of all aspects of the subject." "Without question," he continues, "comparative reading requires a good background, a good memory, and an agile mind. By the time one has reached college he will have acquired enough of these requisites to begin to read books comparatively. The dividends from such a reading are high: one finds that it is no longer necessary to read more than a few books in detail because much of the detail will have become apparent in large clumps during flashes of comprehension." Nevertheless, he says, imagination, mental flexibility, thoroughness, orderliness, persistency, observation, judgment and accuracy are traits which are important in literature search.

Part II contains the literature which are classified under approximately 120 major subject headings and about 500 subheadings in mathematics, physics, and related phases of engineering science. The major subject headings and some of the subheadings contain discussions of the literature under each, defining the subject and providing numerous cross-references before the entries are listed. Citations give author, title, edition, publisher, place, date, volume, and pages.

The physicist, the mathematician, the scientist, the engineer, the student and researcher will find the book an invaluable guide to both general and specific reference materials in their particular fields of study.—A.B.G.

Introductory Calculus. By Donald E. Richmond. Reading, Mass., c1959. xv, 207p. Price, $5.50.

This is a well-organized introductory text in Calculus suitable for students with no knowledge of trigonometry and analytic geometry. It starts with functions and their graphs, and the concept of continuity and limits. The second chapter deals with derivatives and its applications. In the third chapter the idea of areas under a curve and the various applications of this idea have been clearly and concisely presented. Chapter 4 deals with the characteristics of exponential functions defined by 2^x and e^x. A novel treatment of analytic trigonometry with the use of complex numbers is contained in the concluding chapter.

The author should be commended for attempting to attain a three-fold objective in the presentation of each chapter of the book; namely, (*1*) to develop only one central theme in each chapter; (*2*) to develop in the reader a firm understanding of the nature of mathematical thinking; and (*3*) to enable him to acquire as well some feeling for mathematical proofs.

This book will be useful for students of pharmacy, medicine and allied sciences where intensive knowledge of mathematics is not required—C.G.B.

Disease, Life and Man. Selected Essays. By Rudolf Virchow. Translated and with an introduction by Lelland J. Rather. Stanford, Cal., Stanford Univ. Press, 1958. viii+(2)+273p. Price, $5.00.

In this book, Lelland J. Rather has translated ten selected essays of Rudolf Virchow, a prominent German scientist who attained eminence in politics, archeology, social medicine, and anthropology during the latter half of the nineteenth century. The book opens with an introduction in which the translator discusses the ideas of three investigators, William Harvey (1578–

1657), Claude Bernard (1813–1878), and Rudolf Virchow (1821–1902) on the methodology of science. He reviews their works and provides an assessment of their contributions to scientific thought.

Virchow's essays discuss such subjects as the split between "scientific" and "practical" medicine; the significance of medicine as anthropological and social science; human understanding and the central nervous system; the pathology of the cell as the basis of the medical viewpoint; the human being as a unified commonwealth of cells; the distinction between the cause and the nature of the disease; and changes in the conception of life from Paracelsus to Hunter.

Of interest to readers would be Virchow's theory of the nature of disease and his insistence on the necessity of applying the scientific method to the study of life and man, both of which reflected and contributed to a habit of thought beginning to obtain dominance in his own time. He reduced disease to what he considered its core of actuality; and it appeared to him a physical, chemical, or anatomical disturbance of the fundamental unit of life—the cell. His conception of scientific method is very close to that of the present day.

The book is intended for the educated public since it is part of the author's credo that medicine should be a cultural force in the life of every individual, a form of *paideia,* as it was among the ancient Greeks.—P.T.

Journal of Nuclear Energy: Part C: Plasma Physics, Accelerators, Thermonuclear Research. Vol. 1, Nos. 1 & 2, October, 1959. Edited by J.V. Dunworth. London, Pergamon Press, 1959.

The Journal of Nuclear Energy portrays the growing international cooperation in science. It is devoted to publishing contributions from scientists of different countries. This particular part of the series is a compilation of papers on the subject of plasma physics, thermonuclear research, and accelerators, originally appearing in a great many journals of different languages. Prompt and accurate translations of the numerous and important papers produced, particularly in Russia, are made available for physicists who are unable to read the originals. Thus this periodical merges some scientific disciplines and publicizes developments in this growing field of technology.

This issue contains articles by Americans, Englishmen, Russians, and Japanese. The articles deal with fusion and the scientific attempts at producing controlled thermonuclear reactions from which useful power can be generated. Both theoretical and experimental aspects are treated.

The trend towards closer cooperation between different nations of the East and the West epitomized by the Journal of Nuclear Energy is indeed most heartening.—M.R.E.

New Principles in Quantum Mechanics. By H.C. Dudley. New York, Exposition Press, 1959. 151 p. illus, tables. Price, $4.50.

This book is delightful spoof on modern science and scientists who take themselves too seriously. The author has in a way "twisted the lion's tail" by postulating the existence of a new particle, the polaron, with properties not too different from those of particles postulated by nuclear scientists, to wit, particles such as the electron, proton, neutrino, meson, etc., and properties such as charge, spin and mass.

The book is liberally sprinkled with quotations from the philosophical works of some scientists, and newspaper articles on science. It also has illustrations, diagrams of theories propounded by the author and his colleagues (and photographs of his scientific apparatus).

All in all, it is a gentle bit of whimsey, highly appropriate for a scientist's summer night of light reading.—M.R.E.

1970 Without Arms Control. Washington, D.C., National Planning Association, 1958. 72 p. tables. (NPA pamphlet No. 104.) Price, $1.25.

"1970 Without Arms Control" is the first of a series of reports by the Special Project Committee on Security Through Arms Control. It describes weapons as they exist today and as they may be expected to develop by 1970 without arms control.

It predicts that significant trends in design of weapons will make arms controls which are feasible today, very uncertain tomorrow.

A listing of aircraft and missiles in existence or under development in the United States and Russia, based on publicly available data, is appended to the report.—P.N.A.

Plasma Physics and Thermonuclear Research. Vol. 1. Edited by C. Longmire and others. London, Pergamon Press, 1959. 612 p. (Progress in nuclear energy series XI.) Price, $15.00

Plasma Physics and Thermonuclear Research is a very laudable attempt to put together in one volume summaries of controlled thermonuclear research up to the time of the 2nd Geneva Conference (1958).

The volume contains contributions from scientists of different countries notably the U.S., U.K., and U.S.S.R. The friendly spirit of competition that exists between nations in the scientific field as in the political and economic fields is interesting to note. For example, the Americans take particular pains to explain that the neutrons given off in thermonuclear machines are, so far, not yet of truly thermonuclear origin. The Russians, on the other hand, contend that the origin of these neutrons is immaterial, provided that they are produced in substantial quantities. This is understandable, considering the fact that the first public announcement of neutron emission was made by Kurchatov of Russia.

Quite detailed descriptions of the different machines employed in thermonuclear research are given.

Truly, this book is a must for those who want to keep abreast of this fast-growing field.—M.R.E.

Reports on the Productive Uses of Nuclear Energy. By the NPA Special Policy Committee on the Productive Uses of Nuclear Energy. Washington, D.C., National Planning Association, ©1955–1958. 12 reports.

In 1953 the National Planning Association thought of making a broad inquiry into the policy issues arising from the prospective use of nuclear energy for non-military purposes. The subject "productive uses of nuclear energy" has so many ramifications that it was decided to emphasize only a few economic aspects. These are:

(*a*) The comparative need for and effects of nuclear energy in a number of underdeveloped and developed economies during the next 2 or 3 decades.

(*b*) The description of the total energy position of these economies as it may influence and be influenced by the emergence of nuclear energy.

(*c*) The immediate economic prospects and urgency of need for competitive nuclear energy in the U.S. and other countries, particularly the underdeveloped economies.

(*d*) The identification of the major issues of public policy for the U.S. and other countries that are intimated by the economic findings.

The research program launched resulted in these 12 reports and studies. They are intended to be helpful to leaders in government, industry, labor and the professions in providing economic background on such questions as: are the prospects good or poor that nuclear power in the next few years will not only become competitive, but over the long term, also low-cost?

Does the U.S. have a near-term domestic need for nuclear power, in the light of her low-cost conventional energy sources? In the absence of nuclear energy is there some risk that fossil fuel reserves may be consumed at a rate that will result in greatly increased fuel and power costs. Are the needs of the underdeveloped and industrial countries for nuclear energy urgent?

These factual and informative reports will certainly help in clarifying many questions on the timely issues of non-military uses of nuclear energy.—A.P.C.

Turning Points in Physics; a Series of Lectures Given at Oxford University in Trinity Term 1958. By R.U. Blin-Stoyle and others. Amsterdam, North Holland Publishing Co., ©1959. 192 p. Price, 12 shillings.

Turning Points in Physics is a very appropriate book for students of physics who are interested in its philosophical aspects.

The first four chapters are brief expositions on modern concept such as the wave-particle duality of radiation and matter, quantum theory and its implications, the uncertainty principle, complementarity, etc., and Einstein's theory of Relativity.

A very interesting chapter, "The Decline and Fall of Causality" is a resumé of the inroads of probability theory into the science of physics. It traces the beginnings of the mechanical point of view from the time of Galileo to Newton's Principia. The study of the sub-microscopic world of atoms and atomic nuclei, however, forced a radical change in the physicist's concept of phenomena as being governed strictly by the relationship between the cause and effect. This came to be recognized when in dealing with millions of submicroscopic particles, meaningful results could be obtained only through the use of probability laws which have their logical conclusion in Heisenberg's Uncertainty Principle.

"Toward New Concepts, Elementary Particles," the last chapter, is an excellent review of the latest experimental and theoretical work on elementary particles. Its author, D.H. Wilkinson, has succeeded in presenting the different conservation laws such as statistics, spin, and parity in a most orderly and readable manner. Students of physics should find this last chapter particularly interesting and well worth the cost of the entire book.—M.R.E.

Low-level Irradiation. Edited by Austin M. Brues. Washington, D.C., American Association for the Advancement of Science, 1959. ix, 147 p. illus, tables. (AAAS publication No. 59.) Price, $3.75.

The eight papers included in this volume were read by various scientists and men of public affairs at a symposium organized by the Section of Zoological Science of the American Association for the Advancement of Science, co-sponsored by the U.S. Atomic Energy Commission and the Division of Biological and Medical Research of the Argonne National Laboratory and presented at the Indianapolis meeting on December 30, 1957. That symposium was organized to investigate the "known facts concerning the biological effects of low-levels of long-continued irradiation, how the several changes are brought about, what general problems present themselves, what responses arise as a consequence of them."

For purposes of discussion, the book was divided into 2 parts. In the first, the papers describe present-day knowledge on low-level radiation effects and discuss what some of the approaches of study are, what the present status of research is on the subject, and how scientists are handling the problem.

The second part is on a broader perspective for it presents papers by individuals who view the problem of the effects of human exposure to radiation not only from the standpoint of the "scientific investigator trying to think up questions which are sensible to answer, but from the standpoint of persons whose responsibilities require that they make decisions based in part on a scientific background and partly on many other problems related to it." These related problems are those of public health, public information, public decisions and the philosophy of science.

The effects of low-level irradiation and radioactive fallout has been a very much discussed subject in our day. But never has there been such a subject based on so few scientific facts available. Because of the great dearth of information, the public has consequently felt bewildered and insecured. This book, a very timely scientific appraisal of the whole question, helps clarify a lot of this confusion.—A.P.C.

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PUBLICATIONS AVAILABLE

CONTENTS AND INDEX. THE PHILIPPINE JOURNAL OF SCIENCE, vol. 1 (1906) to vol. 10 (1915). Bureau of Science Publication No. 8 (1917). Paper, 442 pages. Price, $2.00 United States currency, postage extra.

SECOND TEN-YEAR INDEX. THE PHILIPPINE JOURNAL OF SCIENCE, vol. 11 (1916) to vol. 28 (1925). Compiled by Winifred I. Kelley. Bureau of Science Monograph 26. Paper, 382 pages. Price, $2.00 United States currency, postage extra.

CHECKLIST OF THE ANTS (HYMENOPTERA: FORMICIDAE) OF ASIA. By J. W. Chapman and S. R. Capco. Institute of Science and Technology Monograph 1 (1951) new series. Paper, 327 pages. Price, $2.00 United States currency, postage extra.

NOTES ON PHILIPPINES MOSQUITOES, XVI. GENUS TRIPTEROIDES. By F. E. Baisas and Adela Ubaldo-Pagayon. Institute of Science and Technology Monograph 2 (1952) new series. Paper, 198 pages with 23 plates and 4 text figures. Price, $2.50 United States currency, postage extra.

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